Renewable and Sustainable Energy Reviews 25 (2013) 335–350

Contents lists available at SciVerse ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Biodiesel from the perspective of Turkey: Past, present and future

Emre Aytav [a,*], Günnur Kocar [b]

[a] Turkish Land Forces NCO Vocational College, Automotive Sciences Department 10110 Balikesir, Turkey
[b] Ege University Solar Energy Institute, 35100 Bornova, Izmir, Turkey

ARTICLE INFO

Article history:
Received 23 July 2012
Received in revised form
17 April 2013
Accepted 20 April 2013
Available online 29 May 2013

Keywords:
Energy consumption
Biofuels
Biodiesel production
Turkey biodiesel policies
Vegetable oil
Oilseed production

ABSTRACT

Energy is an indispensable factor of today's developed and developing societies. However, supplying most of the energy need through nonrenewable fossil fuels has come to the threatening position for both the energy demand and the sustainable development in the future. For this reason, most of the developed countries have started to reduce the foreign dependency in order to stabilize their economies and head towards more environmental and renewable resources. Particularly, economic fluctuation and environmental damages depending on the oil need which increases day by day raise the importance of biofuels. Biodiesel developed as an alternative of diesel fuel has reached up to 17.6 billion liters of production amounts over the last 20 years. It is predicted that this increase would be much more rapid in the next decade and reach up to 42 billion liters. EU, Argentina, Brazil, Malaysia and the USA supply the 93% of the biodiesel production of the world. Turkey, which is 78% foreign-dependent in terms of energy and imports its 93% of oil need, supported biodiesel production in 2000s in order to close its current deficit and prevent oil's environmental damages. However, the desired aims could not be achieved and many biodiesel facilities were shut down. Along with the amendments in the legislation of petroleum products by the end of 2011, it is aimed that the biodiesel sector would be boosted through arousing interest in biodiesel again.

Contents

1. Introduction

While the world population by years has been increasing with an average of 1.45%, this accrual is about 70 million per year. Though this amount is to be underestimated for it is 0.001 percentage of the world population of 7 billion, it does not change the reality that the needs of the people which is about the population of Turkey have to be fulfilled. As it is a necessity to enhance and increase the technology in order to satisfy these personal needs, there definitely appears an obligation to provide the energy the system demands. When it comes to the year of 2030, it is expected that the world population would reach about 8.5 billion people [1,2]. While the consumption of energy for per person was an average of 1.5 tons of oil equivalent (toe) in 1990, this amount became 1.7 toe with the increase of technology and population in 2000. The development of every part of the energy resources depends on the utility of that resource.

When the world's total carbon dioxide (CO_2) emission production was analyzed; it reached 33158.4 million tons by increasing at

* Corresponding author. Tel.: +90 266 221 23 50x4471; fax: +90 266 221 23 58.
E-mail address: emreaytav@gmail.com (E. Aytav).

1364-0321/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.rser.2013.04.018

the ratio of 282.3% in energy consumption in a period of 45 years [3,4]. When considered that the CO_2 gas can remain in the atmosphere without undergoing a change, it is understood that how much these values have great risks for the future. When the CO_2 oscillation on sectoral basis, 41% of the energy production is caused from power generation and heating, 23% of it is caused from vehicles and transport, 20% of it is caused from industrial treatments, 6% of it is caused from residential areas and 10% of it is caused from other areas of usage [5–7]. The emission values occurring as a result of energy use and increasing day after day cause some unfavorable results in terms of climate and health and reach the conditions that can endanger the existence of future generations in the world [5,8–14,15].

While environmental and renewable energy resources have importance for developing countries like Turkey which imports vast amounts of fuel for use of energy and also aims sustainable growth, they also give different opportunities. In this study, biofuels which is among the renewable resources will be examined. The potential of biodiesel in Turkey and in the world; production of raw material today, its quantity, its economy and its effect on agricultural policies are to be searched.

2. Energy policies in the world

While energy requirement increase incrementally along with rapid increase in population and industrialization, fossil fuels such as coal, gas and oil have recently caused significant problems in terms of pollution and besides they have been running low rapidly for they are exhaustible resources. Accordingly, studies on reusable and consistent energy resources which is supposed unlimited practically are becoming the government policy and sizable investments are done.

As it is seen in Fig. 1, which shows the world's energy production, the highest proportion belongs to the oil. While coal production was done almost twofold of the other energy resources in 1990s, it caught the oil production with the 3499 million tons of oil equivalent (Mtoe) amount in 2010; as for the gas production, it reached the amounts close to the oil production with an increase of 180% over the last two decades. According to Fig. 1, while opening new oil wells and new fields and the increase in production no longer look possible especially in oil production, it is clear that a tendency is shown to nonrenewable energy resources [16,17]. It is estimated that oil production is to decrease from

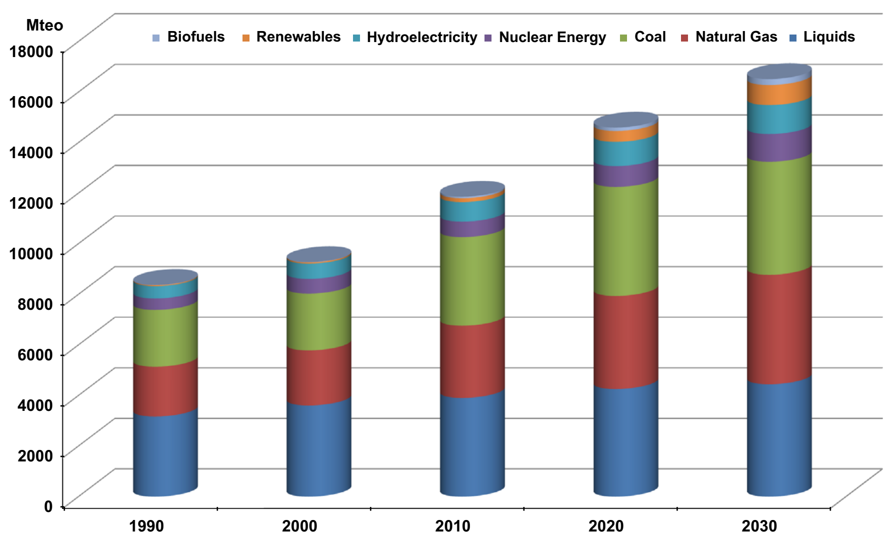


Fig. 1. World energy production [16,18].

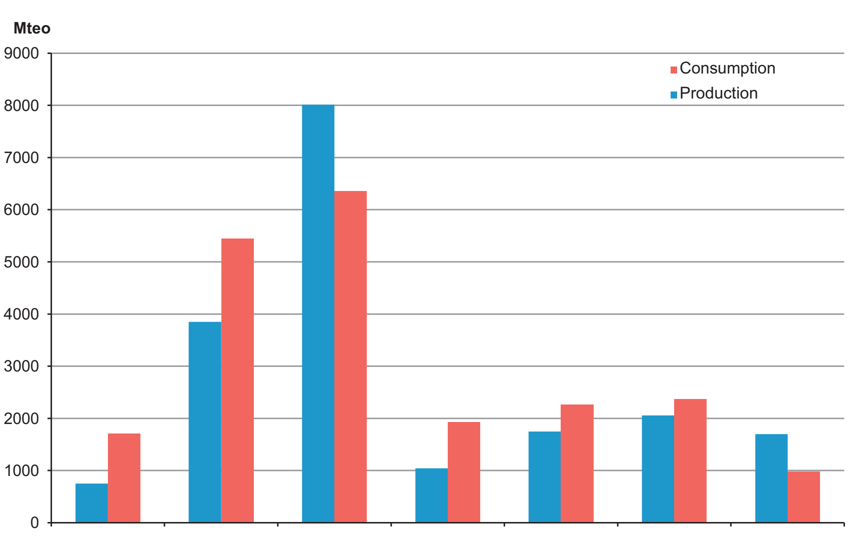


Fig. 2. Energy production and consumption values of the country and by region [8,18].

38.7% to 26.9%; coal production is to decrease from 27.43% to 27.03%; and gas production to increased from 21.85% to 26.22% in a four-decade period between 1990 and 2030. Though the proportion of biofuels are low in total energy production today, the project to increase the production of biofuels in proportion to 3211.3% in the period of 1990–2030 show that they will have an important position in the policy of future energy production. With regard to the world's energy production; as oil production increased in proportion to 23.2%, gas production increased in proportion to 59.7%, coal production increased in proportion to 55.7%, nuclear energy increased in proportion to 35.5%, hydroelectric increased in proportion to 34.6%, biofuels increased in proportion to 709.9% and renewable energy resources increased in proportion to 339.4% between 1990 and 2010.

Energy production and consumption variation of the world are depicted in Fig. 2. As can be seen in Fig. 2, all of the countries are foreign-dependent with respect to energy [18]. The differences between the energy production and consumption in 2010 is −958.4 Mtoe in the European Union (EU); −1600 Mtoe in OECD member countries; −517.9 in the USA; and −883 Mtoe in non-EU countries. While the contribution of non-EU countries in total energy production has been 67.54%, their share to the consumption has been 53.85%. The rise in the price of oil per barrel 126.3$ by an increase of 4210% total through 42 years is substantial to show how the energy cost of the countries has increased [8,19,20].

3. Energy policies in Turkey

Energy is one of Turkey's most important development priorities. Hence, utilization of indigenous renewable energy sources is of vital importance for Turkey to reduce its dependence on foreign energy supplies, provide supply security and prevent the increasing greenhouse gas emission. Turkey's energy policy targets to increase the currents hare of renewable energy from 20% to 30% incoming years [21].

Energy is the basic input for the production process in order that the social and economical development could occur. As the industry was just about to be settled in 1960s, the energy consumption was considerably low. As a result of rapid industrialization and urbanization in 1970s, primary energy production increased 4.3% and the consumption increased 6.4%. The share of the oil in total energy consumption increasingly reached the level of 46.7%. Energy consumption in Turkey increased rapidly particularly after 1980 together with the rapid industrialization and population growth [22]. Industry and service industry gained importance after Turkey expanded trade more and more as a result of neoliberal policies. As is seen today's data, the ratio of the fossil resources in total energy consumption is 90%. Turkey, which is not a producer of gas and oil, supplies 96% of its gas demand and 90% of its oil demand by imports. Because the dependency on importation is so high, energy security and continuity of energy supply have vital importance for Turkey [17,23–29].

As seen in Fig. 3, when the energy production and consumption amounts are compared in Turkey, it is monitored that the difference between the energy production and consumption amounts has been increasing annually. Accordingly, while the difference between the production and consumption was 54,453 Ttoe in 2000, it reached 76,773 Ttoe in 2010. It is thus important that Turkey should quickly diminish the external dependence and start to use its domestic resources more productively. Besides environmental factors also affect the type of the energy resource used. It is necessary that improvements that are parallel to technological developments particularly energy efficiency on the side of demand and a dissemination on the usage of renewable energy resources alternative to fossil fuels on the side of supply should be made [30].

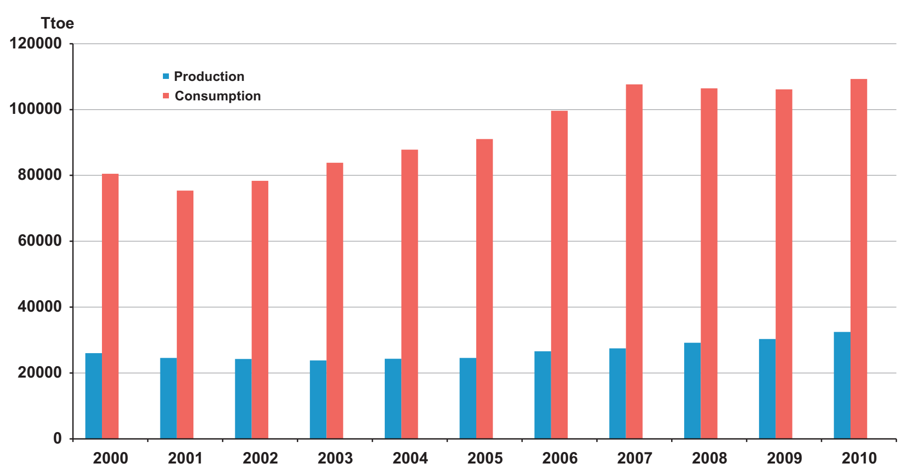


Fig. 3. Turkey's energy production and consumption statistics [31].

Table 1
Energy projection of Turkey (Ttoe) [31].

Year	Industrial	Housing	Transport	Agriculture	Non-energy	Total final energy demand	Cycle sector	Total primary energy demand
2012	49,270	32,650	22,370	4,775	2,640	111,705	31,156	142,861
2013	52,056	34,500	23,700	4,988	2,706	117,950	32,940	150,890
2014	54,766	36,450	25,100	5,210	2,774	124,300	35,911	160,211
2015	57,633	38,507	26,541	5,443	2,844	130,968	39,186	170,154
2016	60,991	40,400	28,000	5,690	2,915	137,996	40,459	178,455
2017	64,842	42,150	29,480	5,943	2,988	145,403	42,520	187,923
2018	69,144	43,900	31,000	6,203	3,063	153,310	45,601	198,911
2019	73,795	45,700	32,500	6,475	3,140	161,610	48,626	210,236
2020	78,732	47,549	34,039	6,753	3,219	170,292	52,132	222,424

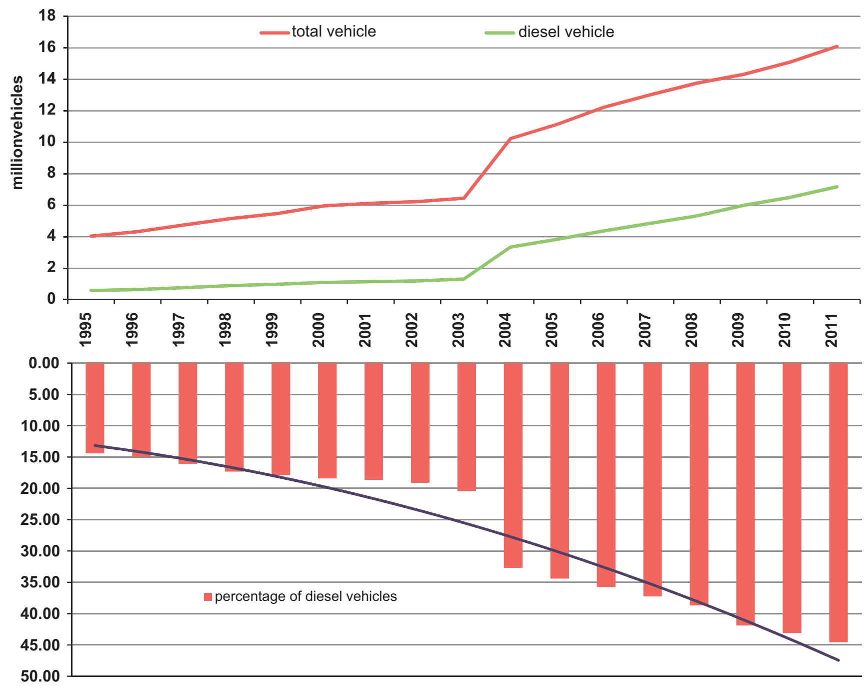


Fig. 4. The number of motor vehicle in Turkey highways and the percentage of diesel vehicles [38,39,187,188].

When the process of two decades on sectoral basis examined, while residential sector has increased in proportion to 88% by rising from 15,358 Ttoe to 28,868 Ttoe, industry sector has increased in proportion to 111% by rising from 14,542 Ttoe to 30,628 Ttoe. As for transportation sector, energy consumption has increased in proportion to 76% by rising from 8723 Ttoe to 15,328 Ttoe. Energy consumption amounts in agricultural sector in Turkey has increased from 1956 Ttoe to 5089 Ttoe and it has been the sector whose energy consumption amount has increased most by increasing 160% in a two-decade period [31].

The 2020 projection related to the Blue Book published by the Ministry of Energy in 2011 is shown in Table 1. It is predicted from the table that in a decade, the energy need would increase at a rate of 157% for the industry sector; it would increase at a rate of 64.7% for the residential sector; it would increase at a rate of 122% for the transportation sector; and it would increase at a rate of 32.7% for the agricultural sector [31].

Rapidly developing industry and the moves on providing the energy need have brought about some environmental problems. Especially greenhouse amounts have increased rapidly and some climatic changes have been in the meantime [32,33]. The evaluation of greenhouse gas emission made by Turkey Statistics Institute (TUIK) shows that CO_2 emission related to transportation and agriculture reached up to 60.12 million tons in 2009 and it increased at a rate of 89.3% compared to 1990. When the CO_2 emission in 2009 was examined, 20.1% of total CO_2 emission has been seen to originate from transportation and agricultural sector [34]. It is known that there are some differences only in maximum sulfur content between Turkey and European countries with regard to fuel quality and fuel technology [35]. The Turkey scenario of IPCC (*Intergovernmental Panel on Climate Change*) (National Communication 1, 2007) states that the mean yearly temperature in Turkey would increase between mean 2.5–4 degrees in the years ahead; winter precipitations would decrease between the rates of 20% and 50% in the regions involving the Aegean Region, the Mediterranean Region and Southeastern Anatolia Region; and the flood risk would increase in the northern regions [36].

The distribution of the vehicle numbers in transportations sector and the percent of diesel vehicles in total vehicle numbers are given in Fig. 4 [37,38]. So, the level of income and the standard of life depending on the increase in industrialization also reflect on the number of vehicle use. While there existed 4,040,923 vehicles in 1995, this amount reached up to 16,089,528 in 2011. Vehicle numbers increased at a rate of 398% during 17 years. The situation of diesel cars in this change is much more striking. While there were 528,131 diesel cars in 1995, it happened to increase 7,171,145 in 2011. The numbers of diesel vehicle use increased at a rate of 1358% in this same meantime. Their share in total vehicle numbers increased from 14.41% to 44.57%. Their being more economical especially in 2000s made people use diesel cars more. This progress is also expected to increase in future years. The amount of diesel fuel oil consumed in Turkey has also increased depending on the increase in the number of diesel vehicles. The consumption of diesel fuel, which was 9.6 billion liters in 1995, has reached up to 16.7 billion liters till 2011.

4. The potential of biofuels

The situations that fossil fuels affect all countries negatively with its economical and environmental problems and rapidly running out of resources for energy need have caused to the change of energy policies. For this reason, countries have started to head toward renewable resources in their future policies. Biofuels, in particular, are seen as an alternative to the solutions connected to such different disciplines as energy, environment and agriculture. These countries have headed towards producing biofuels in order to decrease the burden of energy prices to their budgets that have increased so far. Countries such as the USA and China, in particular, have focused their attention on biofuel production so as to provide the security of the energy supply together with alternative resources and to lessen the dependency on oil that is mostly imported.

Biofuels obtained from biomass have become a current issue as an alternative energy resource so as to offer a solution to environmental and climatic problems. Together with the extreme

increase on price hikes for oil in 1970s, Brazil and the USA started to produce bioethanol in order to lighten the burden of oil over the budget. Supply decrease that appeared as a result of the decreases on the international oil prices in 1986 and the increases on the prices of the agricultural raw materials in the later 1980s made it necessary to examine the availability in terms of being economic. 1990s were the years when concentrations on these examinations and researches increased. The beginning of 21st century became the heyday of biofuel sector in its history. Biofuels that became the primary agenda topic in the world owing to the excessive price hikes for oil attracted other countries' attention except from the USA and Brazil. Enterprises that were started for biofuel production and consumption by many countries helped the recognition of biofuels worldwide. World's biofuel production which advanced as from 2000 reached 89 million liters in 2008. With such amount of production that corresponded an average of 51 Mtoe, about 2% of the fuel consumption on transportation sector in the world was covered by biofuels [39,40]. On the other hand, EU countries that saw the biofuels as a remedy for preventing environmental problems occurring in 2000s wanted to increase the use of biofuels in order to prevent such environmental problems as global warming and climate change [41–48]. The desire for enabling rural development by increasing the employment and income caused other EU countries Germany in particular to head towards biofuel production [49].

After EU signed White Paper, Green Paper and Kyoto Protocol, it has been aimed to provide a legal basis for the positive developments on alternative energy and biofuels. To achieve these targets, the parliament of Europe and European Council signed the Biofuel Directive including the incentives related to the use of biofuels and other alternative energy sources on transportation on 8th of May, 2003, Just before signing the Biofuel Directive, in 2003, some new and alternative income opportunities were created for the farmers producing biofuel raw material within the scope of Common Agricultural Policy. Hoping to solve the raw material problem using Common Agricultural Policy means, the European Union has opened Biofuel Directive for signature soon after these practices. The energy use in transportation sector in the union, 30% overuse of energy within the total energy consumption especially the increase in CO_2 emissions resulting from transportation have been emphasized and some significant regulations related to the biofuels have been made. Along with Biofuel Directive, some incentives and legal obligations have been imposed on using biofuels proportionately on transportation sector. It's been stated in this directive that alternative energy should have a 2% share in total energy consumption till 31st of December, 2005 and the percent of the alternative energy use should be increased to 5.75% in total energy consumption on 31st of December, 2010 [50,51].

In spite of the legal obligations and regulations made by European Commission, the target of using 2% of biofuel use set on 31st of January, 2005 could not be fulfilled. On that time, the foreseen 2% use of biofuels was achieved at a percentage of 1.4, the average of the member countries. As well as the obtained 1.4% mixture ratio has not been a bad mean, falling behind the objectives has brought up new enforcements related to biofuels [52]. This regulation has been followed by EU 2005 Biomass Action Plan and 2006 EU Strategy for Biofuels [53,54]. In summary, EU continues to insist on biofuels, examines and evaluates this issue closely from every angle.

In order to overcome the problems and evaluate the developments on biofuels, EU prepared a progress report on biofuels in 2007 and shared it with member countries [55]. The evaluations for biodiesel and ethanol, defined as second generation biofuel and which is increasingly used as commercially, have been carried out. Intending to make the regulations necessary for practicing biofuel policies be obeyed, EU treats flexibly on legal regulations as well as being insistent. Considering the potentials of countries and other factors on biofuels, the developments of the countries are evaluated, respectively, and thus slowly-developing member countries or the member countries having some problems ease psychologically.

The change in energy policies reflected on biofuel production values. As seen in Table 2, biofuels increased with a rate of 645.8% worldwide in a decennium between 2000 and 2010 [18]. While Brent oil prices increased 279% over the last decennium, CO_2 emission values rose 130% in the same period. This increase on CO_2 emissions and unstoppable rise on oil prices can be indicated among the major reasons for the increase on biofuel production. When regional production values are examined, OECD member countries have increased their biofuel productions in proportion to 966.7% and the European Union increased its production in proportion to 1404% over the last decennium. Even Commonwealth of Independent states being independent on outside financial sources started to analyze their present biofuel potential in their country. In these countries where biofuel did not be produced until 2004, a production close to the world statistics was monitored in 2010.

The USA prefers bioethanol among biofuels and obtains bioethanol from corn [56]. Brazil that produced bioethanol for many years uses sugar cane as raw material. In countries such as Indonesia and Malaysia almost all of the biofuels consist of biodiesel that is produced from palm oil. Also the European Union prefers biodiesel among biofuels.

4.1. Biodiesel policies and production in the world

Biodiesel is an alternative diesel fuel made by animal or vegetable oil through chemical reaction called transesterification [57–69]. Chemically, it can be defined as a mono alkyl ester of long chain fatty acids [70–73]. Biodiesel can be produced from a lot of

Table 2
Biofuel production in the world [18].

Thousand tons of oil equivalent	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Change 2010 Ćover 2009 (%)	2010 share Ćof total (%)
North America	3,096	3,399	4,100	5,339	6,470	7,612	9,906	13,922	19,637	22,399	26,355	17.70	44.50
S.and Cent.America	5,248	5,639	6,281	7,228	7,292	8,091	9,405	12,302	15,927	15,994	18,264	14.20	30.80
Europe and Eurasia	744	951	1,305	1,704	2,081	3,401	5,103	6,546	8,091	10,597	11,354	7.10	19.20
Asia Pacific	82	89	238	491	603	833	1,323	1,736	2,628	3,094	3,275	5.90	5.50
Total World	9,176	10,048	11,930	14,767	16,452	19,944	25,743	34,512	46,284	52,098	59,261	13.80	100
OECD	3,841	4,350	5,406	7,045	8,549	11,013	15,054	20,494	27,728	32,569	37,130	14.00	62.70
Non-OECD	5,336	5,734	6,523	7,723	7,903	8,930	10,688	14,018	18,566	19,528	22,131	13.30	37.30
European Union	744	951	1,305	1,704	2,073	3,378	5,052	6,469	7,944	9,970	10,447	4.80	17.60
Former Soviet Union	–	–	–	–	11	22	28	49	129	645	913	41.50	1.50

raw materials. Vegetable oils (like colza, soya, cotton, safflower, palm and sunflower), animal oils (generally tallow), waste oils (used frying oil) and micro algae oils are among them [74–78]. As for transgenic (genetically modified) agricultural products, they are just raw materials produced for the need of fuel oil. Choosing raw material mostly depends on its geography. Biodiesel is used as fuel oil in the form of pure and diesel+biodiesel mixtures. These fuels are: B5; 5% Biodiesel+95% Diesel; B20: 20% Biodiesel+80% Diesel; B50: 50% Biodiesel+50% Diesel; B100: 100% Biodiesel [79–83].

When the overall emission values of biodiesel are compared with petroleum diesel; while unburned hydrocarbon amount is decreasing at a rate of 20% in B20 fuel, it is decreasing at a rate of 67% in B100 fuel. When carbon monoxide (CO) values are examined; while it is decreasing at a rate of 12% in B20 fuel, it is decreasing at a rate of 48% in B100 fuel. Particle amount (emission) is decreasing at a rate of 12% in B20 fuel and 47% in B100 fuel. These are common harmful emission values. Apart from these, such emissions causing cancer in the human body as sulfate, PAH (Polycyclic Aromatic Hydrocarbons), nPAH (nitrated PAH's) also decrease [84]. However, the values can increase a little with regards to nitrogen oxide (NO_x) emissions [85–88]. While the NO_x values can be 2% higher than normal diesel NO_x emission values in B20 fuel, it is 10% higher in B100 fuel [89]. When it is examined in terms of greenhouse gas effect, with the use a kilo of biodiesel, about 3 kilos of CO_2 gas are absorbed. Hence, this is a suitable means for preventing global warming and shortening the CO_2 gas [87,90,91].

Because of such reasons as the decreasing the greenhouse gas emission, countries' help to decrease the dependency on crude oil export, trade opportunities for domestic agricultural products, and its support on agriculture by enabling new labors and also the shortage of raw material blocking commercial practices and limiting the persistence in production, biodiesel was ignored for a long time. But, the climatic changes and environmental disasters that appeared in 2000s along with the increasing energy need parallel to the development in industrialization forced the countries to make changes in their energy policies.

The first use of vegetable oils as a diesel fuel oil dates back to many years ago. Rudolph Diesel, the inventor of diesel engine, used peanut oil as fuel oil in 1900s [74,78,92,93]. The first official document about the fuel oil known as biodiesel today was the study with a patent number of 422.87 done by G. Chavanne from Brussels University in August 31st,1937 [94,95]. In this study, biodiesel was defined as Palm Oil Ethyl Ester. A catalyst transesterification method was used here. This produced fuel was used on commercial vehicles working between Brussels and Leuven in the summer of 1938. The only difference in this use from petro-diesel was thought as viscosity. In order to decrease viscosity, studies were carried out on the field of sunflower methyl ester. These fuel oils were used as emergency fuel oil during Second World War and then ethyl or methyl ester were named as "biodiesel" in an article published in 1988 and this term gained worldwide currency [96,97]. However, the existence of petroleum fuel oil abundantly and their cheapness and the expensiveness of alternative motor fuels as vegetable oil vis-à-vis petroleum products decreased the competitive capacity with oil and enabled the engines to develop in a way to work with oil products.

As biodiesel production could not make any significant progress in 1900s, it stayed below the level of one billion liters till 2002 [40,78]. Biodiesel reached up to 17.6 billion liters of production amounts between 2008 and 2010 thanks to the practices applied over in recent years. When the 2020 world biodiesel projection is examined, this amount is estimated to reach up to 41.9 billion liters. It was seen in the previous years that crude oil prices, macroeconomic phenomenon and changes in the policies affected the biodiesel market substantially. For this reason, countries are also maintaining their studies so as to increase domestic raw material. Nowadays, while 7.35% of biodiesel produced worldwide is imported, it is estimated that this amount is to decrease to the ratio of 2.35% and countries are thought to increase the use of raw material.

While 318.2 million liter of biodiesel was produced in the European Union in 1995, this value reached up to 3.62 billion liters in 2005 and 9.92 billion liters in 2010 [98]. EU member countries increased their production about 32 times in a fifteen-year period. Although the USA headed towards bioethanol for their biofuel production, it is clearly seen that they also increased their biodiesel production substantially. Biodiesel production in the USA, which was 15.4 million liters, increased 323 million liters in 2005 and 953 million in 2010. Starting its biodiesel production in 2005, Brazil increased its 0.6 l of production up to 2.4 billion liters in 2010. Countries' biodiesel production amounts are seen in Fig. 5 in reference to the agricultural outlook report of 2010–2020 prepared by OECD-FAO. In the report, it is expected in 2020 that India would increase its biodiesel production at a rate of 1175%; the USA would increase its biodiesel production at a rate of 320%; the EU member countries would increase its biodiesel production at a rate of 77.5% in total; Canada would increase its biodiesel production at a rate of 88.6%. Since the USA focused on producing corn in 2008 and 2009, oily seed production amounts and consequently biodiesel production decreased. However, it is estimated that this decrease would end and the USA would be in the position of being an importing country in the future.

While the world biodiesel production has been increasing year by year, the development of biodiesel market has been very low worldwide. The report prepared by the secretariat of OECD (Organization for Economic Development and Cooperation)-FAO

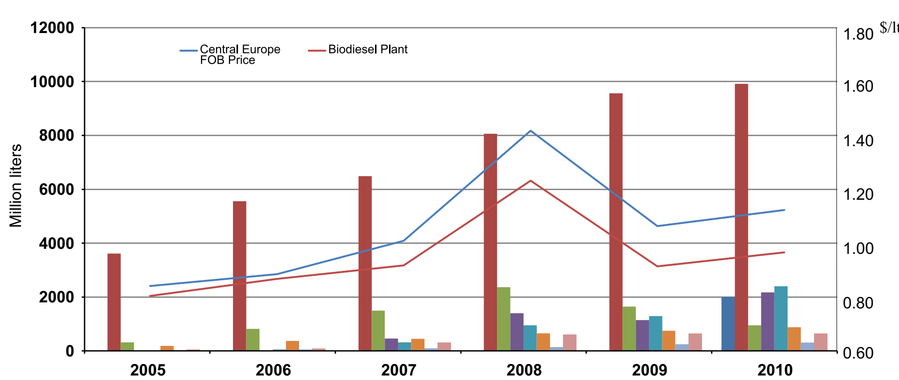


Fig. 5. Biodiesel production and price [99,100].

(Food and Agriculture Organization) showed that the amount of biodiesel produced worldwide was 17.2 billion liters in 2009. It is estimated that this amount is to reach up to 42 billion liters in 2020. 65.84% of biodiesel export was done by Argentina in 2010. However, 99.5% of the import in the same period was done by EU member countries, according to Food and Agricultural Policy Research Institute (FABRI) [99]. It was not expected that the countries to do imports and exports change in the future.

While the price of a liter of biodiesel was 1.11$ in 2010, it cost 1.05$ in 2009. The expected price of 2012 is thought to be 1.26$ in 2012. No increase is expected in the 8-year-period till 2020 and it is thought to remain between 1.42$ and 1.45$ [98]. It is thought to be due to the increase of transgenic oil seed, the expected increase in the production of second and third generation inedible oily seed and bringing inert fields into use. However, the 20% increases in biodiesel prices today are known to be caused by the increase in the prices of the oily seed and vegetable oil because the highest cost of biodiesel results from the raw material. For this reason, it is affected highly by the volatility in oily seed caused by climatic or any other reason.

The agricultural outlook report of OECD-FAO concerning 2011–2020 gives the information that the first price data worldwide dated back to the year of 1996. In that year, the price of a liter of biodiesel was recorded as 0.82$. While the price of a liter of biodiesel was 0.86$ in 2000, it became 0.87$ in 2005. During these five years the prices were not changed; on the contrary, it was recorded as it decreased at a rate of average 3%. An increase was also recorded in biodiesel prices parallel to the increase in raw materials after 2006. Due to global crisis, the prices of oily seed increased above the line especially in 2008 and as a result, the price of one liter biodiesel increased at a rate of average 40%.

While daily biodiesel production was 286 thousand barrels in 2009, this amount became 306 thousand barrels by increasing about 7%. 194 thousand barrels of biodiesel, 63.4% of this amount, was produced by OECD member countries as seen Fig. 6. France took the first place with 47 thousand barrels and Germany took the second place with 44 thousand barrels among these countries. As for Non-OECD member countries, Brazil took the first place with 37 thousand barrels of production. According to the Medium-Term Oil and Gas Markets published by International Energy Agency in 2010, a 71% increase is expected in daily biodiesel production by reaching it up to 458 thousand barrels in a six-year-period in 2015[8]. When the distribution of daily biodiesel production among countries in 2015 is examined, it is estimated that the share of OECD member countries in total production is to decrease at a rate of 1.83%. Besides, it is expected that the USA would be the leading country in producing daily biodiesel with 69 thousand barrels. While it is estimated that daily biodiesel production worldwide is to increase 71% in a six-year period, the USA is expected to increase its production at a rate of 92%. This change is thought to arise from making biofuels as government policy in order to lessen the fuel need based on oil and minimize the environmental damage; and it is thought to arise from providing the required financial and technological support in order to make it happen. It is indicated that the USA is to be followed by Brazil with 53 thousand barrels, Germany and France with 49 thousand barrels. When the graph which is prepared with regard to the daily production amounts is examined, it is seen that the production curves are getting close to the horizontal position in time. According to this, as long as current raw material and production techniques are continued to be used, it is seen that daily production amounts are not to increase much and are going stay in the horizontal position. In order to increase their biofuel production in the future and develop other sources apart from raw materials for nutritional purposes, countries are heading towards second and third generation biodiesel production and they are developing bio refinery technology.

4.2. Biodiesel policies and production in Turkey

In Turkey, the first studies related to biodiesel started after it was brought into question in Agriculture Congress in 1931; a study by the name of "Use of Vegetable Oil in Agriculture Tractors" was started in Ataturk Forest Farm in 1934 and then it attracted attention in Second Development Project prepared by Ataturk in 1936 [100]. After the death of Ataturk, though the Second World War blocked the plan to be implemented, certain amounts of biofuels were supplemented to the vehicles used in the Turkish Army in 1942 [101,102]. The nationally and internationally deficient policies of Turkey go back to 1945s. So, both energy and agriculture sectors are completely subject to external sources. In addition to this, biogas, biodiesel and biofuels were taken into consideration during the oil shock in 1970s as an alternative to fossil fuels but it could not be continued. The responsible governments from the beginnings of 1980s till today did not put alternative fuels on their agenda [103]. Biodiesel was brought to Turkey's agenda after 2000 again [104]. Biofuels first took their place in the blended products by names of biodiesel and bioethanol in "The Petroleum Market Law" dated December 4th, 2003 and numbered 5015. Then, biodiesel production increased rapidly when the biodiesel producers got the one million tons installed capacity and capacity report. Biodiesel Production Companies most of which were established in 2005 concentrated on research-development activities (R&D activities), collaborated with universities, got Technology and Innovation Funding Programs Directorate (TEY-DEB) projects from Turkish Scientific and Technological Researches

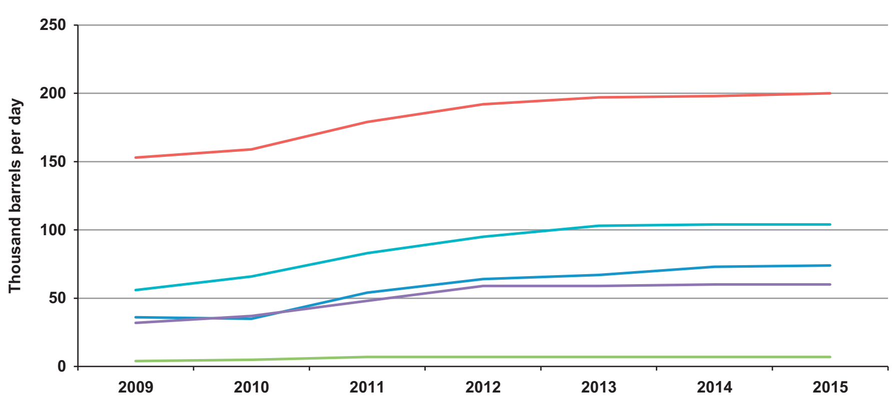


Fig. 6. Daily biodiesel production values [8].

Institution (TUBITAK) and they made about 90,000 t actual production. Vegetable oil import objected for biodiesel production was 42,000 t in 2005.

In order to evaluate bio ethanol, biodiesel and biomass sources effectively nationwide, a Bio Energy Project was launched by General Directorate of Electrical Power Resources Survey and Development Administration operated under Ministry of Energy and National Resources in 2003. Within the scope of the project, it was targeted that the use and the production of biofuels in Turkey should be popularized and biomass sources should be used affectively with the help of biomass techniques [105,106].

Though the increasing biodiesel production along with the development of the sector seemed to be a positive development, such reasons as the difficulties in standards, poor production, lack of infrastructure on biodiesel made it necessary to have the sector under tight control. Biodiesel was accepted as fuel oil with “Regulations on Technical Criteria to be used in Oil Market” published in September 10th, 2004 in Turkish Official Gazette numbered 25,579 and “Oil Market License Regulation” published in June 17th, 2005 in Turkish Official Gazette numbered 25,495 [107]. Together with the acceptance of biodiesel as fuel oil, all the processes up to the imports, distribution, transportation and ultimate consumer started to be evaluated within the scope of license.

Turkish Standards Institute (TSE) began to study and analyzed the biodiesel standards proposed by General Directorate of Electric Power in 2003. After the studies and analyses done by Turkish Standards Institute, TS EN 14,214 auto biodiesel and TS EN 14,213 fuel oil biodiesel standards were accepted in October in 2005 in Turkey [108–110]. Standards decided by TSE were accepted by Energy Market Regulatory Authority (EPDK) with the assize numbered 623/1 in December 29th, 2005 and they were decided to put on the market with “Agreement regarding Crude oil, Fuel oil, Bunker Fuel, Mineral Oil and Base Oil” published in Turkish Official Gazette dated December 31st, 2005 and numbered 26,040 [111]. In order to put the biodiesel on the market; the substance with 3824.90.99.90.54 Customs Tariff Statistic Position (GTIP) was regulated to be released as auto biodiesel and the substance with 3824.90.99.90.58 GTIP was regulated to be released as fuel oil biodiesel.

From then on, “Communiquè on Technical Regulation regarding the Production of Diesel Oil Types, Their Procurement by Domestic and Foreign Funds and Their Market Supply (Petroleum Products Serial No: 1)” was published on Turkish Official Gazette dated December 30th,2005 and numbered 26,039 [112]. Along with this communiqué, it enabled biodiesel to be blended with diesel fuel in proportion to 5%. The TS EN 14,214 standard, an auto biodiesel standard, was exactly accepted thanks to “Communiquè on Technical Regulation regarding the Production of Auto Biodiesel, Its Procurement by Domestic and Foreign Funds and its Market Supply (Petroleum Products Serial No: 2)” published in Turkish Official Gazette dated January 5th,2006 and numbered 26,044 [113,114]. Biodiesel fuel's iodine value within TS EN 14,213 standard has been accepted by increasing it from 120 to 140 through “Communiquè on Technical Regulation regarding Domestic and Foreign Funds and Its Supply”.

While the circumstances regarding biodiesel sector and the studies to organize the market were progressing, amendments were done on Income Tax Law numbered 5479 in March 30th, 2006 stating that there were unfair competition problems and a Special Consumption Tax (OTV) of 0,65 TL per liter (TL/L) was added to auto biodiesel numbered 3824.90.99.54 GTIP [115]. This tax applied to auto biodiesel was increased to 0.72 TL/L afterwards. Owing to this high-rate tax affecting the sector very badly, most producers came to a standstill or made a break in production. The increasing OTV practices led the biodiesel companies to produce zero-rating fuel oil biodiesel [40].

In an attempt to enliven the sector that came to a standstill because of high OTV amounts, blending the auto biodiesel produced from domestic raw material at a rate of 2% became exempt from OTV with the Decree dated June 5th,2006 which was published in Turkish Official Gazette dated December 8th,2006 and numbered 26,370 [116]. Even all the biodiesel produced in Turkey could be produced by using domestic raw material, in the case of 100% use of biodiesel; it should be taken into consideration that 98% of it is dependent on OTV. It must be hard for biodiesel, which is subject to both customs and high OTV, to compete with oil considering that there are other petroleum products that are not subject to customs or OTV. Thanks to some regulations done on petroleum market law in January 17th,2007, companies that make their production in accordance with some identified standards and some regulations prepared by EPDK have gained right to blend their biodiesel with a rate of 2% oil [117]. On the other hand, some legal regulations for the sector have continued and then producing companies are held responsible to report their annual production amounts (in a quarterly period) and their expected production amounts for the following year to the EPDK [107]. Because of the increasing OTV in biodiesel sector, companies that began to produce biodiesel fuel instead of auto biodiesel stopped their production due to the additional OTV of 0.72 TL/L to biodiesel fuel by EPDK on the June 6th, 2008 [118]. Consequently, it is clear seen that biodiesel production period came to its end and biodiesel production came to a standstill along with this OTV applied on biodiesel fuel. While the oil prices were continuing to increase; Turkey is one of the countries where the oil was the most expensive and also new suitable strategies and models were developed for the conditions in the world agriculture, energy agriculture in Turkey could not go beyond a certain point but a political device.

The 2010 and 2011 reports of EPDK on Oil Market Sector showed that the production capacities of licensees had been decreasing over the years. These values were 1,065,924 t/year for 2008, 918,199 t/year for 2009 and 812,200 t/year for 2010 and 561,217 t/year for 2011. Also, Petkim Petro Chemistry Holding Incorporated Company having a license had a capacity of 1,606,000 t/year raw material use for 2010; and Sanko Petro Chemistry Products Tire Manufacturing and Trading Inc. had a capacity of 1,000,000 t/year raw material use. The total of both countries' capacity of raw material use was 2,606,000 t/year. Biodiesel production in 2010 had only one licensee regarding its import and export sales. The 2010 data also showed that while 7460 t of biodiesel were produced, 3011 t of these amounts were exported for they could not be used in Turkey [119]. According to the 2011 data, 11,646 t of biodiesel were produced, 10,136 t of biodiesel were sold to the distribution license holders [120].

When the change of the biodiesel production capacity by years in Turkey is examined, a serious decrease has been seen. Biodiesel production, which was 166,112 t in 2006, reached up to 1,071,363 t by increasing at a rate of 545% in 2007. Biodiesel production capacity decreased because of some negativity like adding taxes in 2008 and the following period. Biodiesel production capacity has decreased to the level of 561,217 t as from 2011 [107,119–123]. It is considered that biodiesel production capacities would increase again along with the amendments in legislation in which the addition of biodiesel into diesel fuel was made obligatory.

With the legislation of “Communiquè Amending Communiquè on Technical Regulations regarding Diesel Types (Petroleum Products Serial No: 22)” which was published in September 27th,2011 dated and 28,067 numbered Turkish Official Gazette by EPDK, it has been made obligatory that in the diesel types supplied to the market as fuel oil, fatty acid methyl ester (YAME) content produced by domestic agricultural products should have at least 1% as from January 1st,2014; at least 2% as from January

1st,2015; and at least 3% as from January 1st,2016 [124]. Along with this amendment on the legislation, it is aimed to make use of biodiesel for its economical and environmental benefits by reigniting it which came to a stopping point in the previous periods.

Apart from political movements, the studies have increasingly been continued by researchers in universities and it is still aimed to set a scientific structure by evaluating this issue especially within the regional bounds of possibility. The academic studies done within Southeastern Anatolia Project (GAP) [125–128], studies on different products and production mechanism [129–132], studies on production [133–142], declaration presented in national seminar, symposium and conferences [143–150] show that this issue is scientifically active no matter how unstable the political side of this business is.

In addition to this, considering the international database retrospectively, there are quite many publications contributing to set the scientific background from Turkey. When a search has been made with the key words such as "biodiesel", "bio-diesel", "transesterification" and "oil methyl ester" in the database of ISI Web of Knowledge, it is seen that there are 7527 scientific papers registered. While 17.44% of these registers belongs to the USA; 12.59% belongs to China; 8.85% belongs to Brazil; 8.55% belongs to India; 5.33% belongs to Japan, a 3.1% of these registers belongs to Turkey. With their share in international publications on biodiesel production and use, countries such as Canada and South Korea have surpassed be leading European countries having such as Germany, France and Spain. In this statistical research on biodiesel, Turkey has been the 8th country while South Korea has been the 9th; Germany has been 10th; France has been 12th; Canada has been 13th and England has been 15th country. It is hard to understand why the contribution of Turkey to the scientific background on this subject cannot be put into practice.

Comparing biodiesel production with publication numbers; while the increase in academic publications worldwide supports the production values, it is not the same in Turkey as the values do not support each other. In Turkey, 74 different associations give support to scientific background of biodiesel, 56 of which are private and state universities. Apart from all these studies, examining all the completed dissertations published in the official page of the Council of Higher Education, there have been 158 master's and doctoral dissertations about biodiesel completed from 2002 to 2012 [151]. 26 of these dissertations have been completed as doctoral dissertations. The key words of "biodiesel", "biyodizel" and "biyomotorin" have been used in this search.

Even in years between 2003 and 2011 when the biodiesel policies of the country above fluctuated, scientific researches and master studies in universities have shown that the irregularity and pessimism in policy do not affect the scientific side of this subject. Even in 2010 when biodiesel came to a stopping point, 16 master (post graduate) studies were carried out. Another point to take into consideration here is that while scientific studies are increasing in countries with high production amounts, the situation in our country has happened differently.

5. The production of vegetable oil and oil seed as raw material for biodiesel

Vegetable oils, which are made from renewable resources, have become very tempt recently due to their environmental benefits. Vegetable oils can be added into the diesel fuel without any phase separation and replaced a fraction of the petroleum distillates. Vegetable oil based fuels are more expensive than petroleum based fuels, but with recent increases in oil prices and decreases its availability, there is renewed interest in employing vegetable oils in conventional diesel engines [74].

More than 350 oil-bearing crops have been identified, of which only soybean, palm, sunflower, safflower, cottonseed, rapeseed, and peanut oils are considered potential alternative fuels for diesel engines. The increase in biodiesel production affects the plantation of the oily seed necessary for raw material and causes it to increase every passing year.

5.1. Vegetable oil and oilseed production in the world

The plantation of oil seed in the world has reached up to 221.18 million hectares by increasing at a rate of 19.7% for the last 14 years. Total oil seed production reached up from 294.57 million tons to 457.62 million tons by increasing at a rate of 55.35% during this very time [152]. It is evaluated that the reason why this ratio has been higher than the cultivated area is the intensification of more conscious and more technological practices. Oily seed import and export have also increased in the same period. While importing reached up to 109.72 million tons by increasing at a rate of

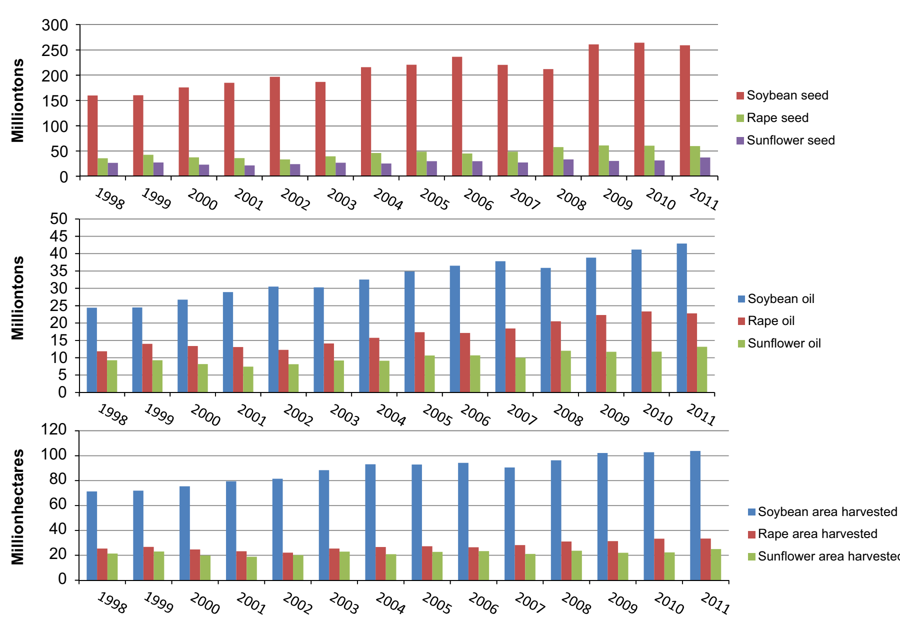


Fig. 7. Oil seed, vegetable oil production and harvested area in the world by years [153].

111.5% between 1998 and 2008, the amount of oily seed export reached up to 114.02 million tons by increasing at a rate of 123.2%.

When the vegetable oil production amounts in Fig. 7 are examined, it is seen that the production was made as 128.62 million tons in 2007; 133.67 million tons in 2008; 140.21 million tons in 2009 and 146.68 million tons in 2010. Oilseed production reached up to 457.62 million tons in 2011, 152.35 million tons of which was used as vegetable oil. 50.57 million tons of this oil was palm oil; 42.91 million tons of it was soybean oil; 22.81 million tons of it was rapeseed oil; 13.17 million tons of it was sunflower seed oil and 22.89 million tons of it was other oils.

Considering all oils seeds, soybean, rapeseed and sunflower seed are common issues in terms of EU, Turkey and the world. According to this, in a 14 year period soybean cultivated areas increased at a rate of 45.6%; oil seed production increased at a rate of 62.2%; and soybean vegetable oil production has increased at a rate of 75.6%. In terms of rapeseed, its cultivated area has increased at a rate of 67.3% and rapeseed vegetable oil production has increased at a rate of 92.5%. In terms of sunflower, its cultivated area has increased at a rate of 16.8; oily seed production has increased at a rate of 39.6% and sunflower vegetable oil production has increased at a rate of 42.1%. While 20.5% of 222.24 million tons of oily seed (for rapeseed, soybean and sunflower) production made in 1998 was produced as vegetable oil, 22.1% of 356.27 million tons of oily seed production made in 2011 was produced as vegetable oil.

When the importing of vegetable oil produced between 1998 and 2011 is taken into account, it has reached up to 60.10 million tons from 29.89 million tons by increasing at a rate of 123.5%; and its export has reached up to 62.77 million tons from 27.67 million tons by increasing at a rate of 126.9%. The distribution of vegetable oil production among countries has been given in the (DELETED) Fig. 8. While the vegetable oil production in the USA has decreased at a rate of 8.2% given in Fig. 8, Indonesia has increased its vegetable oil production at a rate of 38.7%; Malaysia has increased its production at a rate of 6.2%; China has increased its production at a rate of 36.6%, EU has increased its production at a rate of 12.3%; Argentina has increased its production at a rate of 5.2%; Brazil has increased its production at a rate of 16.2%. When the production amounts of 2011 is examined, Indonesia, Malaysia, China, EU, the USA, Argentina and Brazil have their shares in the production, respectively, as 19.1%, 13.7%, 10.7%, 6.3%, 5.9% and 5.2%.

While EU made the most vegetable oil import as 9.67 million tons in 2011, China took the second place with 9.31 million tons, India took the third place with 9.14 million tons and the USA took the fourth place with 3.76 million tons. When the export values are examined, Indonesia has been in the leading position as the country that made the most vegetable oil export with 20.98 million tons. Malaysia has been the second exporting country with 17.73 million tons, Argentina has been the third exporting country with 5.84 million tons and Ukraine has been the fourth exporting country with 2.95 million tons.

Between the years 2000–2001 and 2009–2010, a ton of soybean oil cost 631$; a ton of sunflower oil cost 882$; a ton of palm oil cost 541$; and a ton of rapeseed oil cost 757$. When the period between 2010 and 2011 (October, November and December of 2010 and the months between January and September in 2011 are included) is examined, a ton of soybean oil cost 1225$; a ton of sunflower oil cost 1652$; a ton of palm oil cost 1154$; and a ton of rapeseed oil cost 1367$ [152]. The problems in productions due to environmental disasters and the demand burst in biodiesel come first among the reasons triggering the prices. Along with these, the increase in the costs of production is also evaluated as an essential factor.

Soybean prices in the world increased at a rate of 48% in the 2007–2008 period in comparison to the previous year due to the more demand in the world and less supply [103]. In the meantime, enlargement on the plantation areas, especially in the USA, caused to a decline in the production of soybean production in the world at a rate of 6%. Both the increase in the incomes and the population growth in China made it as the biggest consumer country between the years 2010 and 2011.

Soybean oil was exported by Argentina, Brazil and the USA between 2007 and 2011. Being the leader in exporting, Argentina is considered to hold the 72% of the world market. China and India are considered to be the biggest countries using soybean oil and be the importing countries that have net 48% of the total importing [101].

The price of rapeseed oil ranges close to the prices of soybean and sunflower oil prices. World rapeseed oil production was 59.84 million tons in 2011. The EU, being the biggest rapeseed producer, holds the 39% of the world market. Rapeseed is the finest oily seed for the EU due to the targets set for biofuels. The rapeseed cultivation area was extended at a rate of 43% during the last

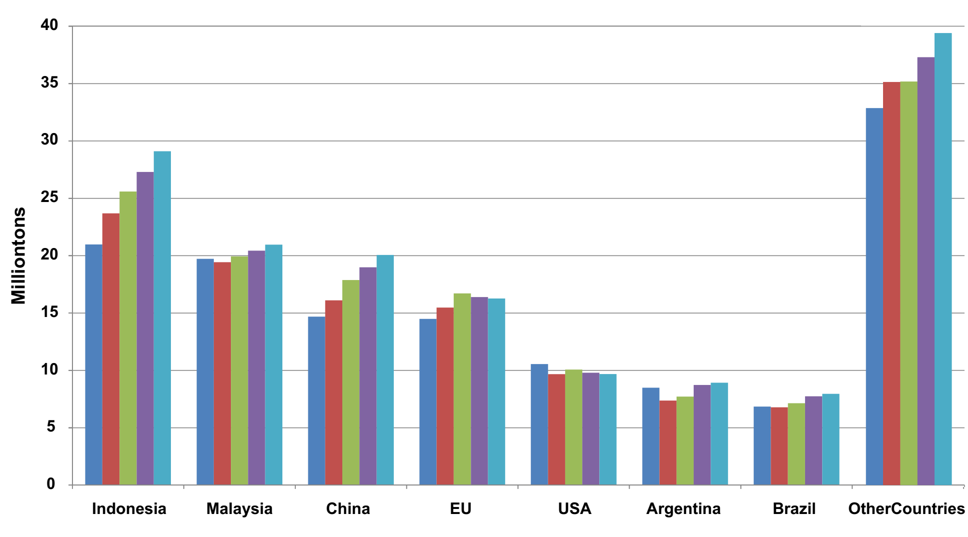


Fig. 8. Oil production amounts of countries for 5 years [99,153].

decennium. The price change during the ten years is the main reason for this extension. An increase at a rate of 367.5% in the prices between 2000–2001and 2010–2011 is the point. Along with the increase in the demand of biodiesel, rapeseed crushing-processing rate is expected to increase together with consumption. While Canada had a share of 70% in rapeseed oil exporting in 2011, China making the biggest rapeseed oil export at the same year had a share of 23.2%.

There had been a sharp increase in the price of sunflower oil in the 2007–2008period due to the increase in the price of seeds and the decrease in the productions. The production of sunflower oil in 2011 was 13.17 million tons. The import and export values of the same year shows that while the EU was the biggest importer of the market with its 1.53 million tons imports, Ukraine has been the biggest exporter with 2.9 million tons [152,159].

5.2. Vegetable oil and oilseed production in Turkey

12 different plants grown in Turkey are benefited from their oil in Turkey these are sunflower, cotton, corn, sesame, soybean, olive, rapeseed, peanut, hash, linen, marijuana and safflower [153,154]. In addition to these plants, nuts such as hazelnut, walnut, almond, pistachio that has considerable oil in their fruit are also produced, but the oils of these plants are generally used in cosmetics and dyeing industry [155].

Sunflower cultivation and thus sunflower oil production in our country has been started in the Marmara Region (especially in Thrace) by immigrant that came from Bulgaria and Romania after the 1st World War. In the meantime, cottonseed oil production was started in 1930s [156].

The major development in vegetable oil industry in Turkey came into sight after 2nd World War. The regularly growing sector either in 1960s or in the beginnings of 1970s has caused oily seed agriculture to develop likewise. Thus, thanks to the joint projects developed by the Ministry of Agriculture and Unilever, the Vinymk seeds provided from Russia were cultivated regularly and then sunflower cultivation and sunflower seed oil production burst and the sector improved rapidly. However, agricultural production never met the needs completely and even if just a drop it was supplied by importation [157]. As a result of free import after 1980, the shortage of raw oil was tried to be met by importation steadily. The shortage of raw oil which was 150–200 thousand tons reached up to 900 thousand tons by increasing rapidly in this period [158].

According to the data of Turkey Statistics Institute, there exists 24,394 thousand hectares cultivated agricultural and perennial areas it the period of 2010–2011. Grains and other vegetable products are planted in 16,333 thousand hectares of this area. Also, oily seeds (soybean, sunflower, rapeseed and cottonseed) are planted in 1177 thousand hectares of this area [160]. During the period of 2010–2011, sunflower has been produced in the 54.5% of this area reserved for oily seed production; cotton seed has been produced in the 40.8% of oily seed reserved area; rapeseed and soybean has been produced in the 4.7% of this oily seed reserved area during the period of 2010–2011. While the amount of total oily seed plantation area decreased between 2010 and 2011, oily seed production reached up to 2786 thousand tons by increasing at a rate of 30.2%. Preferring more productive products, launching more conscious agricultural practices through educating farmers and technological innovations in agricultural instruments may be presented as the foremost reasons for harvesting more crops from less area. Total oily seed production of the country has been 2969.5 thousand tons of in the period of 2010–2011. Turkey's oil seed production and consumption equilibrium by years has been given in Fig. 9 [160,161]. According to the data here, the efficiency ratio has been 50% in all the oily seed productions except for cotton. Especially soybean production efficiency ratio has been 6%. Cotton has been produced only to fulfill the needs.

In producing oily seed, as soybean and peanut are leguminous plants especially, they earth the free azote (nitrojen) thanks to Rhizobium bacteria living in their roots. In this way, they both meet their azote needs and leave a fertile soil rich in azote and organic substance to the plants to be implanted later then [162].

While 60.5% of the oily seed produced in the period of 2000–2001 was cottonseed, this ratio fell to 45.7% in the period of 2010–2011[163]. On the contrary, the share of sunflower oil in total production has reached from 37.4% to 47.4%. The area where soybean and rapeseed are produced consists only 0.5% of total oily seed cultivation area. When the change on production in Fig. 10 within eleven years is examined: there have been no changes except for little fluctuations; but sunflower production has increased at a rate of 65%, soybean production has increased at a rate of 94.5% and rapeseed production has increased at a rate of 56,825%. There has been a sudden increase especially in the

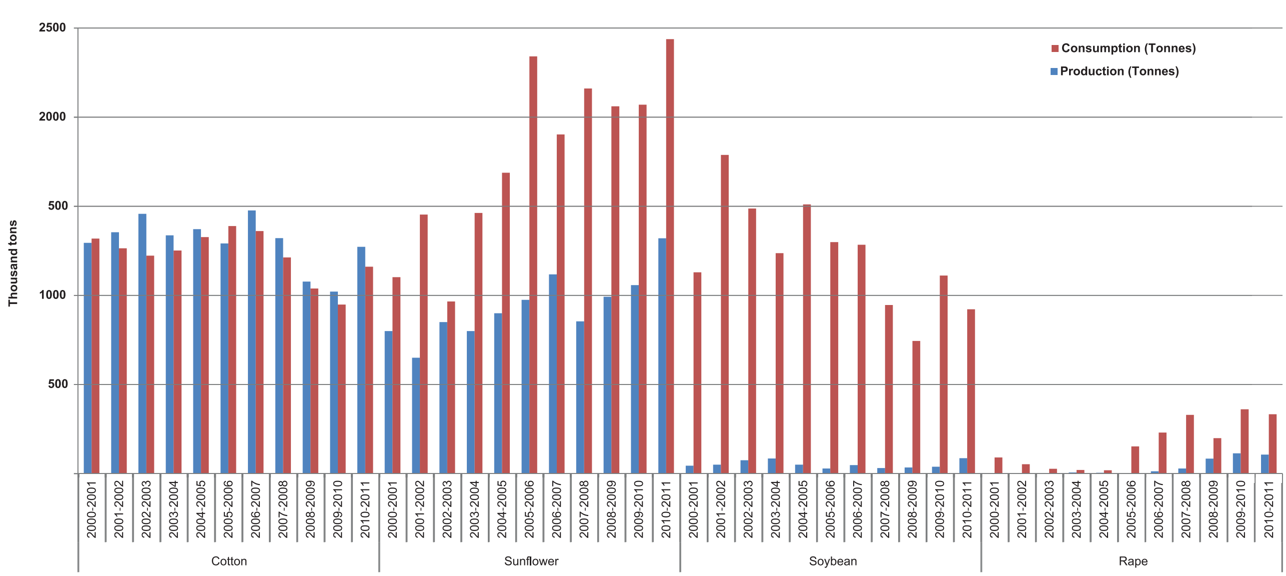


Fig. 9. Turkey's oil seed production and consumption equilibrium by years.

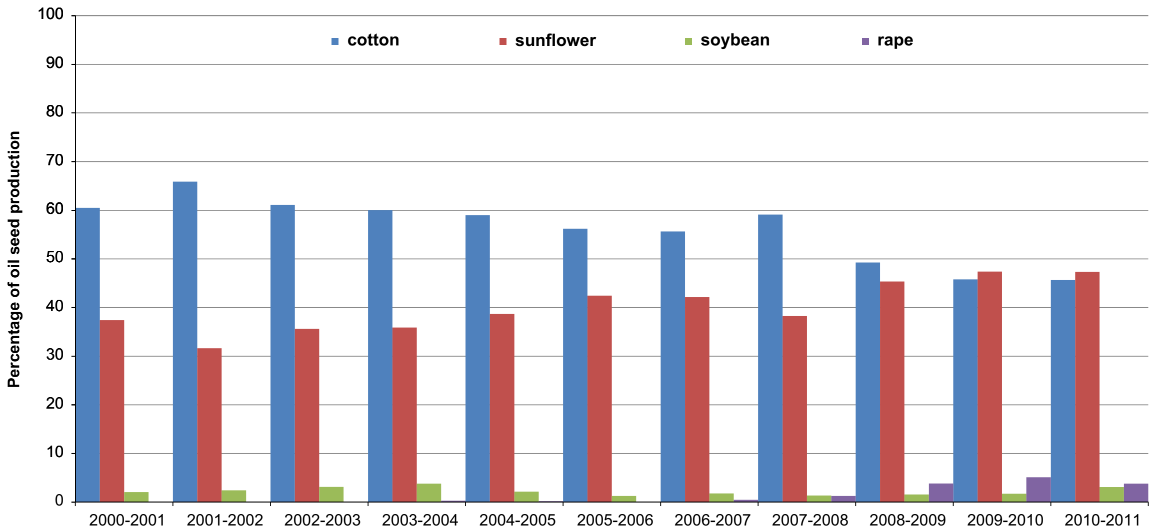


Fig. 10. Percentage of oil seed production in Turkey [161].

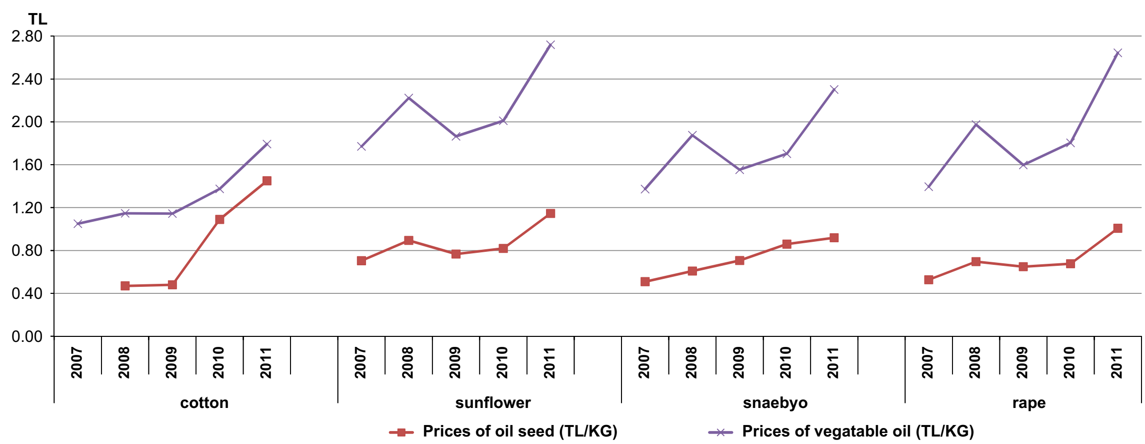


Fig. 11. Prices of oil seed and vegetable oil in Turkey [161,167].

production of rapeseed since 2006 when the biodiesel practices were accelerated. Rapeseed production followed a fluctuating course before. It varied up and down from 5 t to 43,000 t between 1976 and 2006 [164]. Oily seed production in Turkey varying by years prevented Turkey from creating a realistic future projection. There is a similar situation in many other oily seed production. After petrol products that are paid the most, oil and oily seed imports have been paid a lot as the second in order to meet the oil deficit in recent years. Total oily seed refining capacity of Turkey is 4.5 million ton/year and utilization ratio is below 50%. Raw oil refining capacity is 3 million ton/year and utilization ratio is about 52%. Total margarine production capacity is 950,000 t/year and utilization ratio is 52% [165].

Fig. 11 shows the prices of oil seeds and vegetable oil (The vegetable oil prices were calculated by taking monthly averages from source) between the years of 2007 and 2011[160,166]. There exists a lack of retroactive data in the price of cottonseed and sunflower seed. For this reason, assessments are done using the available data. According to this data, kilogram prices of soybean and rapeseed have been 0.92 TL and 1.01 TL, respectively, by increasing two times in the period of 2007–2011. The kilogram price of sunflower for oil has increased from 0.70 TL to 1.15 TL and the rate of increase has been 64.3% between 2007 and 2011. The kilogram price of cottonseed has increased from 0.47 TL to 1.45 TL and the rate of increase has been 208% between 2008 and 2011. These rapid increases in prices are thought to have caused from the lack of supply demand balance or global or national economical crises. When the kilogram prices of the raw oils produced are examined, it is seen that they follow a fluctuating course by years. According to the vegetable oil prices set by vegetable oil industrialists; a kilo of sunflower oil was 2.72 TL; a kilo of canola oil was 2.64 TL; a kilo of cottonseed oil was 1.79 TL; and a kilo of soybean oil was 2.30 TL in 2011. In the period of 2007 and 2011, the price of sunflower oil increased at a rate of 53.7%; the price of canola oil increased at a rate of 88.6%; the price of cottonseed oil increased at a rate of 70.5%; and the price of soybean oil increased at a rate of 67.9%. Although oily seed production amounts fluctuate by years, a low price is given to the farmer as there is a low customs duty; thus, producers have started to prefer grains [155,167]. This pressures the increase in oil production.

When examining the sunflower seed importing amounts in Turkey, it reached from 541 thousand tons to 906 thousand tons by increasing at a rate of 67.5% from 2003 to 2011. In the same though domestic production reached from 350 thousand tons to 707 thousand tons, sunflower seed production for making oil could not be stabilized [154].

When the oil rates of seeds are examined, sunflower seed contains 40–50% oil; rapeseed contains 40–45% oil; cottonseed and soybean seed contain 18–20% oil [40,168–180]. When the need of raw material necessary for biodiesel production is analyzed, 2.2 kilos of rapeseed, 2.5 kilos of sunflower seed or 5 kilos of

cottonseed and soybean seed are needed for a liter of biodiesel [161]. When the prices of necessary raw material for a liter of biodiesel are calculated (these values are calculated using the unit prices set for 2011), sunflower costs 2.88 TL; rapeseed costs 2.22 TL; cottonseed costs 7.25 TL; and soybean costs 4.60 TL. It is seen that the most important cost item arises from the raw material prices.

With the legislation of "Communiquè Amending Communiquè on Technical Regulations regarding Diesel Types (Petroleum Products Serial No: 22)" which was published in September 27th,2011 dated and 28,067 numbered Turkish Official Gazette by EPDK, it has been made obligatory that in the diesel types supplied to the market as fuel oil, fatty acid methyl ester (YAME) content produced by domestic agricultural products should have at least 1% as from January 1st,2014; at least 2% as from January 1st,2015; and at least 3% as from January 1st,2016 [124]. Along with this amendment on the legislation, it is aimed to make use of biodiesel for its economical and environmental benefits by reigniting it which came to a stopping point in the previous periods. However, the statement of "produced by domestic agricultural products" in the related article states that the amount of oily seed currently produced in the country should be increased. According to the oil market sector report of 2011 published by EPDK, the sale of domestic diesel has been 15,236 thousand tons. The diesel sale in domestic market increased about 5% in comparison with the previous year. Depending on this data, if the addition of biodiesel into diesel fuel at a rate of 1% was thought of in 2011, the amount of biodiesel needed would be about 180 million liters. When the need of raw material is evaluated, it is seen that 451 thousand tons of sunflower seed, 397 thousand tons of rapeseed or 902 thousand tons of soybean or cottonseed is to be needed. While this data is analyzed, the production need required for food security should not be ignored.

When examining biodiesel future of Turkey, it is seems distant to meet the needs with current production. The retrospective unbalance in oily seed production and vegetable oil production accordingly makes it difficult to make a good future estimation. Thus, agricultural reforms should be made primarily and it is important to act in a disciplined way. Because of the high costs of oily seed production, it is hard to compete against foreign market prices. While mostly sunflower was cultivated in Thrace in 1980s, changes were seen in regional oil production as the parity between sunflower and wheat prices were unbalanced in a way to benefit wheat in 1990s.

Along with the reduction in oily seed cultivation sites in Turkey, the climatic changes and the deficiencies in infrastructure play an essential role in the productiveness. While the productivity in Spain is 200–250 kg/da, the productivity in Hungary is 160–250 kg/da and the productivity in Argentina is 140–200 kg/da, Turkey has productivity between the range of 127 and 161 kg/da together with the sunflower importing countries such as Russia and Ukraine. While about 40% of oil has been derived from sunflower seed in Turkey, this amount rises up to 49% [153]. The limited watering facilities especially in Thrace and static crop alternation between wheat and sunflower decrease the productivity. As mentioned above, oily seed and oil production has become a strategic product for countries nowadays. Thus, making a discipline and regulation for these products is essential for using the country resources productively.

6. Conclusion

Both Kyoto Protocol and International Energy Agency are the results of the attempts for solving the energy problem of the world via "clean energy" by gathering developed and developing countries under a single roof. In spite of all the economical problems of renewable energy markets as from 2008, the developments and the investments on this field may indicate best that the interest on renewable energy might continue increasingly in the following years. When the consumption policies are examined, it is clearly seen that the countries have made the use of biofuels compulsory with legal arrangements and they have been trying to increase their consumption with numerical targets [181–183]. Using agricultural crops that are grown domestically instead of importing raw materials used in the production process lessens the dependence on foreign sources. The policy that gives the opportunity for creating new employment and income potentials by concentrating on home production has been adopted by lots of countries [184].

Biofuel production in the world has increased at a rate of 550% between years of 2000 and 2010. It has reached up from 59,098 Ttoe to 59,261 Ttoe only between 2009 and 2010. 62.7% of biofuel production in 2010 was made by OECD member countries.

Brazil, Argentina, the USA, Malaysia and particularly EU supply 93% of biodiesel production in the world. Biodiesel production amounts have reached up to 17.2 billion liters by increasing about 17 times from 1990s until today. It is expected that this amount would reach up to 42 billion liters in the next decade. Oily seed production in the world, which was 314.21 million tons in 2000, reached up to 457.62 million tons in 2011. Oily seed production was about 227 million tons in 1992 [104]. Oily seed production depending on the increase of biodiesel production started to increase rapidly in the early 2000s.

Countries that direct world trade on oily seeds determine all the policies about oily seeds. These countries can get involved into decision of the oily seed cultivation areas or the prices and day by day they draw away in this market thanks to their technologies and geographical potentials. For instance, the USA has started an irreversible process by integrating the use of biotechnology into oily seeds [185]. Argentina and Brazil that follow the USA in the use of this technology have even overtaken the USA with their oily seed product outputs. As of today, these three countries shape the soybean trade.

According to the 2011 data by EPDK, there have been 33.6 billion TL (when the 2011 average rate of $ is calculated as 1.680 TL, this cost becomes 56.45 billion $) of oil product imports. The burden of this cost on national economy and its effect on current deficit has been seen. According to the 2011 data; Turkey, which used 56.45 billion $ out of total 241 billion $ imports by buying fuel, is a dependent country on foreign sources to a large extent with regards to energy resources [120,186]. Oil prices increase throughout the world and in Turkey consumers pay the highest prices, plus world of the energy develops new strategies and models, but it's worrying that Turkey still uses energy strategies politically motivated. It is necessary to begin to accept that biodiesel is not a derivative of oil but a derivative of agricultural product. As Turkey is a developing country that has unsolved economical issues; in the case of selling biodiesel at a lower price than diesel fuel, it can take place in the fuel market and be used widely. It is seen that the current agricultural production amounts contradicts with the renewed legal regulation on fuel oils and future biodiesel policies would be hard to put into practice. It is important to secure these increases in a way to supply the needs of the population without risking the current food security.

When the statistics of academic studies are examined, it is clearly seen that there exist enough studies for securing the scientific background in Turkey but, these studies could not brought to field application and national economy. Thus, it should not be forgotten that it is essential that the incentives and supports change into practical applications and the studies in

laboratory environments should turn into production and contribute to the economy.

Considering that Turkey has the second biggest biodiesel production capacity after Germany and the facilities are ignored because of the OTV, the problem is raw material provision. Legal regulations that make use of biodiesel obligatory should be seen a real solution only if the production amounts are increased. Because, when the oily seed production amounts are examined, it fails to satisfy the needs even for use of food. For this reason, it is necessary that domestic oily seed production be increased rapidly. When the current practices are continued, it is clear that dependency on importing oily seed will increase more every passing year for Turkey. In order to prevent this and reach to a rapid production level, it should not be ignored that subventions directed for infrastructure and logistic investments and research–development (R&D) support may be used as important tools as incentives encouraging direct production and consumption are matters of discussion.

The point that has to be kept in mind directed for biofuels; these products are not produced for replacing fossil fuels with cheaper ones but they have a fundamental situation that may affect the energy-environmental and agricultural policies mentioned above. For this reason, while there have been some improvements parallel to the technological developments, particularly the energy efficiency on the side of demand, it is necessary that renewable sources alternative to fossil fuels be used widely.

References

[1] ⟨www.geohive.com/world_population.html⟩, 02/01/2012.
[2] ⟨www.geohive.com/GeoHive_Population_of_continents_regions_and_countries.html⟩, 02/01/2012.
[3] U.S. Energy Information Administration, Annual Energy Outlook 2011, DOE/EIA-383; 2011.
[4] Organization for Economic Co-operation and Development (OECD), Energy, the next fifty year; 1999.
[5] IEA statistics, CO_2 emissions from fuel combustion high lights; 2011.
[6] World Energy Council (WEC), World Energy Insight 2011, Official publication of the World Energy Council (2011).
[7] WEC, Global transports scenarios 2050, IBM Corporation, Paul Scherrer Institute; 2011.
[8] International Energy Agency, Energy technology perspectives 2010, scenarios and strategies to 2050; 2010.
[9] WEC, Pursuing sustainability: 2010 assessment of country energy and climate policies, London; 2010.
[10] WEC, European climate change policy beyond 2012; 2009.
[11] Kaygusuz K. Energy for sustainable development: a case of developing countries. Renewable and Sustainable Energy Reviews 2012;16(2):1116–26.
[12] Oh TH. Carbon capture and storage potential in coal-fired plant in Malaysia–a review. Renewable and Sustainable Energy Reviews 2010;14(9):2697–709.
[13] Ahiduzzaman MD, Islamsadrul AKM. Greenhouse gas emission and renewable energy sources for sustainable development in Bangladesh. Renewable and Sustainable Energy Reviews 2011;15(9):4659–66.
[14] Panwar NL, Kaushik SC, Kothari S. Role of renewable sources in environmental protection: a review. Renewable and Sustainable Energy Reviews 2011;15(3):1513–24.
[15] Kaygusuz K. Sustainable energy, environmental and agricultural policies in Turkey. Energy Conversion and Management 2010;51:1075–84.
[16] BP statistical review, BP energy outlook 2030; 2011.
[17] Torku E. Overview of potential and utilization of renewable energy sources in Turkey. Renewable Energy 2013;50:456–63.
[18] BP statistical review of world energy full report; 2011.
[19] International Energy Agency (IEA), Key world energy statistics; 2011.
[20] Finley M. The oil market to 2030-implications for investment and policy. Economics of Energy& Environmental Policy 2012;1:25–36.
[21] Baris K, Kucukali S. Availability of renewable energy sources in Turkey: current situation, potential, government policies and the EU perspective. Energy Policy 2012;42:377–91.
[22] Erdem ZB. The contribution of renewable resources in meeting Turkey's energy-related challenges. Renewable and Sustainable Energy Reviews 2010;14:2710–22.
[23] Kantorun U. Regional energy policies and Turkey. Bilge Strategy 2010;3:75–97.
[24] Hacisalihaoglu B. Turkey's natural gas policy. Energy Policy 2008;36(6):1867–72.
[25] Pamir N. Energy in the world and in Turkey, Turkey's energy resources and energy consumption. Journal of Metallurgy 2003;134:12–51.
[26] Erdogdu E. An expose of bio energy and its potential and utilization in Turkey. Energy Policy 2008;36:2182–90.
[27] Gokcol C, Dursun B, Alboyaci B, Sunan E. Importance of biomass energy as alternative to other sources in Turkey. Energy Policy 2009;37:424–31.
[28] Yuksel I, Kaygusuz K. Renewable energy sources for clean and sustainable energy policies in Turkey. Renewable and Sustainable Energy Reviews 2011;15:4132–44.
[29] Kaygusuz K, Sari A. Renewable energy potential and utilization in Turkey. Energy Conversion and Management 2003;44:459–78.
[30] Tukenmez M, Demireli E. Renewable energy policy in Turkey with the new legal regulations. Renewable Energy 2012;39:1–9.
[31] Republic of Turkey Ministry of Energy and Natural Resources, Blue Book, Ministry of Energy and Natural Resources Publication; 2011.
[32] Kaygusuz K, Turker MF. Biomass energy potential in Turkey. Renewable Energy 2002;26:661–78.
[33] Keles S, Bilgen S. Renewable energy sources in Turkey for climate change mitigation and energy sustainability. Renewable and Sustainable Energy Reviews 2012;16:5199–206.
[34] TUIK, News bulletin of greenhouse gas emission inventory (131); 2009.
[35] ⟨http://europa.eu/legislation_summaries/internal_market/single_market_for_goods/motor_vehicles/interactions_industry_policies/l28186_en.html⟩, 05/06/2012.
[36] Intergovernmental Panel on Climate Change (IPPC), Scenario for Turkey, National Communication 1; 2007.
[37] Turkish Statistical Institute (TUIK), Turkey of motor vehicles, data for 2010.
[38] TUIK, News bulletin of April (10842); 2012.
[39] OECD and Food and Agriculture Organization (FAO), Agricultural outlook 2008–2017; 2008.
[40] Hatunoglu E. The impacts of biofuel policies on agriculture sector, Planning expertise thesis; 2010.
[41] Demirbas A. Biofuels-green energy and technology. London: Springer; 2008.
[42] Yusaf T, Goh S, Borserio JA. Potential of renewable energy alternatives in Australia. Renewable and Sustainable Energy Reviews 2011;15(5):2214–21.
[43] Sobrino FH, Monroy CR. Critical analysis of the European Union directive which regulates the use of biofuels: an approach to the Spanish case. Renewable and Sustainable Energy Reviews 2009;13(9):2675–81.
[44] Biswas WK, Bryce P, Diesendorf M. Model for empowering rural poor through renewable energy technologies in Bangladesh. Environmental Science & Policy 2001;4(6):333–44.
[45] Lamers P, Hamelinck C, Junginger M, Faaij A. International bioenergy trade—a review past developments in the liquid biofuel market. Renewable and Sustainable Energy Reviews 2011;15(6):2655–76.
[46] Escobar JC, Lora ES, Venturini OJ, Yanez EE, Castillo EF, Almazan O. Biofuels: environment, technology and food security. Renewable and Sustainable Energy Reviews 2009;13(6–7):1275–87.
[47] Kondili EM, Kaldellis JK. Biofuel implementation in East Europe: current status and future prospects. Renewable and Sustainable Energy Reviews 2007;11(9):2137–51.
[48] Markevicius A, Katinas V, Perednis M, Tamasauskiene M. Trends and sustainability criteria of the production and use of liquid biofuels. Renewable and Sustainable Energy Reviews 2010;14(9):3226–31.
[49] Turpeinen H. Innovating in biofuels, workshop on environmental innovation and global markets. Keilaranta: Neste Oil; .
[50] Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003, Official Journal of the European Union, L123/42.
[51] Karaosmanoglu F. Turkey biofuel potential and recent development, Istanbul Technical University, Chemical Engineering Department.
[52] Yasar B. Evaluation of biodiesel production and utilization of biodiesel as an alternative source of energy from the point of view of Turkish agriculture and EU adaptation process, PhD thesis, Cukurova University; 2009.
[53] Communication from the Commission, Biomass action plan (SEC-2005-1573); 2005.
[54] Communication from the Commission, An EU strategy for biofuels (SEC-2006-142); 2006.
[55] Communication from the Commission, Biofuels progress report, Report on the progress made in the use of biofuels and other renewable fuels in the member states of the EU, (SEC-2006-1721, SEC-2007-12); 2007.
[56] United States Department of Agriculture (USDA), United States biobased products market potential and projections through 2025; 2008.
[57] Balat M, Balat H. A critical review of biodiesel as a vehicular fuel. Energy Conversion and Management 2008;49(10):2727–41.
[58] Haas MJ, McAloon AJ, Yee WC, Foglia TA. A process model to estimate biodiesel production costs. Bioresource Technology 2006;97(4):671–8.
[59] Basha SA, Gopal KR, Jebaraj S. A review on biodiesel production, combustion, emissions and performance. Renewable and Sustainable Energy Reviews 2009;13(6–7):1628–34.
[60] Sharma YC, Singh B, Upadhyay SN. Advancements in development and characterization of biodiesel—a review. Fuel 2008;87(12):2355–73.
[61] Tsai WT, Lin CC, Yeh CW. An analysis of biodiesel fuel from waste edible oil in Taiwan. Renewable and Sustainable Energy Reviews 2007;11(5):838–57.
[62] Carraretto C, Macor A, Mirandola A, Stoppato A, Tonon S. Biodiesel as alternative fuel: experimental analysis and energetic evaluations. Energy 2004;29(12–15):2195–211.
[63] Murugesan A, Umarani C, Subramanian R, Nedunchezhian N. Biodiesel as an alternative fuel for diesel engines-a review. Renewable and Sustainable Energy Reviews 2009;13(3):653–62.

[64] Demirbas A. Biodiesel from vegetable oils via transesterification in supercritical methanol. Energy Conversion and Management 2002;43(17):2349–56.
[65] Gerpen JV. Biodiesel processing and production. Fuel Processing Technology 2005;86(10):1097–107.
[66] Ma F, Hanna MA. Biodiesel production-a review 1. Bioresource Technology 1999;70(1):1–15.
[67] Meher LC, Sagar DV, Naik SN. Technical aspects of biodiesel production by transesterification—a review. Renewable and Sustainable Energy Reviews 2006;10(3):248–68.
[68] Cvengro J, Povaz AF. Production and treatment of rapeseed oil methyl esters as alternative fuels for diesel engines. Bioresource Technology 1996;55(2):145–50.
[69] Altin R, Cetinkaya S, Yucesu HS. The potential of using vegetable oil fuels as fuel for diesel engines. Energy Conversion and Management 2001;42(5):529–38.
[70] Tan KT, Lee KT, Mohamed AR, Bhatia S. Palm oil: addressing issues and towards sustainable development. Renewable and Sustainable Energy Reviews 2009;13(2):420–7.
[71] Karmakar A, Karmakar S, Mukherjee S. Properties of various plants and animals feed stocks for biodiesel production. Bioresource Technology 2010;101(19):7201–10.
[72] Venkanna BK, Reddy CV. Biodiesel production and optimization from Calophylluminophyllumlinn oil (hone oil)–A three stage method. Bioresource Technology 2009;100(21):5122–5.
[73] Agugliaro FM, Sanchez-Muros MJ, Barroso FG, Martinez-Sanchez A, Rojo S, Perez-Banon C. Insects for biodiesel production. Renewable and Sustainable Energy Reviews 2012;16(6):3744–53.
[74] Demirbas A. Biodiesel—a realistic fuel alternative for diesel engines. London: Springer; 2008.
[75] Balat M, Balat H. Progress in biodiesel processing. Applied Energy 2010;87(6):1815–35.
[76] Lin BF, Huang JH, Huang DY. Experimental study of the effects of vegetable oil methyl ester on DI diesel engine performance characteristics and pollutant emissions. Fuel 2009;88(9):1779–85.
[77] Peidong Z, Yanli Y, Yongsheng T, Xutong Y, Yongkai Z, Yonghong Z, Lisheng W. Bioenergy industries development in China: dilemma and solution. Renewable and Sustainable Energy Reviews 2009;13(9):2571–9.
[78] Sing SP, Sing D. Biodiesel production through the use of different sources and characterization of oils and their esters as the substitute of diesel—a review. Renewable and Sustainable Energy Reviews 2010;14(1):200–16.
[79] Bozbas K. Biodiesel as an alternative motor fuel: production and policies in the European Union. Renewable and Sustainable Energy Reviews 2008;12(2):542–52.
[80] Yuce I. Evaluation of biodiesel as an alternative fuel in Turkey, in Germany and its utilization in vehicles, Istanbul Technical University, Master's thesis; 2008.
[81] Demirbas A. Current advances in alternative motor fuels. Energy Exploration and Exploitation 2003;21:475–87.
[82] Escobar JC, Lora ES, Venturini OJ, Yanez EE, Castillo EF, Almazan O. Biofuels: environment, technology and food security. Renewable and Sustainable Energy Reviews 2009;13(6–7):1275–87.
[83] Ileri E, Kocar G. Experimental investigation of the effect of fuel injection advance on engine performance and exhaust emission parameters using canola oil methyl ester in a turbocharged direct-injection diesel engine. Energy Fuels 2009;23:5191–8.
[84] Demirbas A. Importance of biodiesel as transportation fuel. Energy Policy 2007;35(9):4661–70.
[85] Schumacher LG. 6V-92TA DDC engine exhaust emission tests using methyl ester, National Soy Diesel Development Board, Missouri; 1997.
[86] Ileri E. Experimental investigation of engine performance parameters and exhaust emissions using canola oil methyl ester in a diesel engine, Ege University, Master's thesis; 2005.
[87] Rajasekar E, Murugesan A, Subramanian R, Nedunchezhian N. Review of NO_x reduction technologies in CI engines fuelled with oxygenated biomass fuels. Renewable and Sustainable Energy Reviews 2010;14(7):2113–21.
[88] Kocak MS, Ileri E, Utlu Z. Experimental study of emission parameters of biodiesel fuels obtained from canola, hazelnut, and vaste cooking oils. Energy Fuels 2007;21:3622–6.
[89] United States Environmental Protection Agency (EPA), A comprehensive analysis of biodiesel impacts on exhaust emissions, Draft technical report (EPA420-P-02-001); 2002.
[90] Narin M. Turkey and the world energy farming, Second National Congress of Economics. Izmir 2008.
[91] Atabani AE, Silitonga AS, Badruddin IA, Mahlia TMI, Masjuki HH, Mekhilef S. A comprehensive review on biodiesel as an alternative energy resource and its characteristics. Renewable and Sustainable Energy Reviews 2012;16(4):2070–93.
[92] Demirbas A. Biodiesel fuels from vegetable oils via catalytic and non-catalytic supercritical alcohol transesterifications and other methods: a survey. Energy Conversion and Management 2003;44(13):2093–109.
[93] Lin L, Cunshan Z, Vittayapadung S, Xiangqian S, Mingdong D. Opportunities and challenges for biodiesel fuel. Applied Energy 2011;88(4):1020–31.
[94] Gizlenci S, Acar M. Energy crops and biofuels industry report: cultivation of energy crops and biofuels. Black Sea Agricultural Research Institute; 2009.
[95] Anastasov A. Biodiesel-basic characteristics, technology and perspectives, biotechnology and biotechnological equipment. Special Edition 2009;23(2):755–9.
[96] Knothe G, Gerpen JV, Krahl J. The biodiesel handbook. Urbana, Illinois: AOCS Press; 2005.
[97] Bailer J, De Hueber K. Determination of saponifiable glycerol in bio-diesel. Fresenius' Journal of Analytical Chemistry 1991;340(3):186.
[98] OECD and FAO, agricultural outlook 2011–2020, Paris; 2011.
[99] Food and Agricultural Policy Research Institute (FAPRI), 2011 World agricultural outlook; 2011.
[100] Ministry of Economy, Industry Research Board, second five-year industrial plan, Ankara; 1936.
[101] Ilkdogan U. Development of oil seeds trade in the world and EU an evaluation in terms of Turkey, Ministry of Agriculture and Rural Affairs of Turkey Foreign Affairs and EU Coordination Department, EU Expertise thesis; 2008.
[102] National Economy and Society for savings (MITC), First congress of agricultural, Specialized reports, Ankara; 1931.
[103] Acaroglu M. AB surecinde Turkiye'de biyodizel üretimi “sorunlar-öneriler”, World Energy Council Turkish National Committee, Turkey 10th Energy Convention; 2010.
[104] Tunalioglu R, Afacan T. Biodiesel policies in Turkey and assessment of existing institutional structure, Symposium on Biofuels and biofuel technologies, Ankara; 2007.
[105] Karatas F. The energy sector and policies in Turkey with in the context sustainable development, Master thesis, Gaziantep University; 2008.
[106] Oksay S, Iseri E. A new energy paradigm for Turkey: a political risk-inclusive cost analysis for sustainable energy. Energy Policy 2011;39:2386–95.
[107] Republic of Turkey Energy Market Regulatory Authority (EPDK), Petroleum Market Law, 〈http://www.epdk.org.tr/mevzuat/kanun/petrol/petrol.doc〉, 05/06/212.
[108] Turkish Standards Institution (TSE), Automotive fuels–fatty acid methylesters (FAME) for diesel engines–Requirements and test methods (TS EN 14214); 2005.
[109] TSE heating fuels–fatty acid methylesters-requirements and test methods (TS EN 14213); 2005.
[110] Guven O, Aktas T, Kilic E. Türkiye kosullarında üretilen biyodizelin bazi özelliklerinin standartlara uygunluğunun ve yakıt püskürtme miktari üzerine etkilerinin belirlenmesi. Journal of Tekirdag Agricultural Faculty 2010;7(2):167–77.
[111] EPDK, The decision on crude oil, fuel oil, bunker fuel, lubricants and base oils, 623/1 Decisions of the board-5/c; 2005.
[112] Kararları EPDK Kurul. Motorin türlerinin üretimi, yurtdışı ve yurtiçi kaynaklardan temini ve piyasaya arzına ilişkin teknik düzenleme tebliği. Resmi Gazete 2005;26040.
[113] EPDK Kurul Kararları, Otobiyodizelin üretimi, yurtdışı ve yurtiçi kaynaklardan temini ve piyasaya arzına ilişkin teknik düzenleme tebliği, Resmi Gazete (26044); 2006.
[114] Acaroglu M, Aydogan H. Biofuels energy sources and future of biofuels energy in Turkey. Biomass and Bioenergy 2012;36:69–76.
[115] Türkiye Cumhuriyeti Resmi Gazete, Gelir vergisi kanununda değişiklik yapılması hakkında kanun (5479); 2006.
[116] Bakanlar Kurulu Kararı, 4760 sayılı özel tüketim vergisi kanununa I sayılı listede yer alan mallarda uygulanan özel tüketim vergisine ilişkin karar, Resmi Gazete (26370); 2006.
[117] Arslan R, Ulusoy Y, Tekin Y, Surmen A. An evaluation of the alternative transport fuel policies for Turkey. Energy Policy 2010;38:3030–7.
[118] Republic of Turkey Official Gazette, “Amme alacaklarının tehsil usulü hakkında kanunda ve bazı kanunlarda değişiklik yapılması hakkında kanun”, (I–A) numbered list (26898 repeated); 2008.
[119] EPDK, Department of Oil Market, Petroleum market sector report, Ankara; 2010.
[120] EPDK, Department of Oil Market, Petroleum market sector report, Ankara; 2011.
[121] EPDK, Department of Oil Market, Petroleum market sector report, Ankara; 2005–2006.
[122] EPDK, Department of Oil Market, Petroleum market sector report, Ankara; 2007.
[123] EPDK, Department of Oil Market, Petroleum market sector report, Ankara; 2008.
[124] EPDK, Motorintürlerineilişkinteknikdüzenlemetebliğindedeğişiklikyapılmasınadairtebliğ (Akaryakıt Seri No:22), Offical Gazette (28067); 2011.
[125] Cullu MA, Acikgoz M. Guneydogu Anadolu Projesi (GAP)'ın tarimsal kalkınmaya etkileri, Harran University and GAP Management of regional development.
[126] Bengisu G. GAP bölgesinde sürdürülebilir tarım için ekim nöbeti. Alinteri 2011;20B:33–9.
[127] Gursoy S. GAP bölgesinde tarımsal üretimin gelişmesinde mekanizasyonun rolü. Batman University Journal of Life Sciences 2012;1(2):339–46.
[128] Karadogan S, Ozgen N. Analysis of quality change and spread of agricultural products in Southeastern Anatolia in CBS conditions. 4th GIS days in Turkey, Fatih University; 2006.
[129] Ilhan P. Evaluation of tea seed oil for the production of biodiesel, Master thesis, Istanbul Technical University; 2007.
[130] Alptekin E, Canakci M, Hayvansal kökenli yağlardan biyodizel üretimi, VI Yeni ve Yenilenebilir Enerji Kaynakları Sempozyumu, Kayseri; 2011.

[131] Gaytancioglu O. Trakya'da hibrit ayçiçeği tohumu kullanımının Türkiye Ekonomisine katkıları, Master thesis, Trakya University; 1994.
[132] Canakci M, Özsezen AN. Evaluating waste cooking oil as alternative diesel fuel. Gazi University Journal of Science 2005;18(1):81–91.
[133] Tasdan K. Biyoyakıtların Türkiye tarım ürünleri piyasalarına olası etkileri biyobenzin-etanol. Tarım ve Mühendislik 2005;75:27–9.
[134] Kumbar N, Unakıtan G. Trakya bölgesinde kanola üretiminin ekonomik analizi. Journal of Tekirdag Agricultural Faculty 2011;8(1):75–80.
[135] Sabanci A, Oren MN, Yasar B, Ozturk HH, Atal M. Türkiye'de biyodizel ve biyoetanol üretiminin tarım sektörü açısından değerlendirilmesi. Cukurova University, Agricultural Faculty; 2009.
[136] Gunay S. For the purpose of energy farming, sunflower, rape, soybean agriculture in Turkey. Eastern Geographical Review 2008;20:163–82.
[137] Oguz H, Ogut H, Gokdogan O. Türkiye tarım havzaları üretim ve destekleme modelinin biyodizel sektörüne etkisinin incelenmesi. Igdir University Journal of Science and Technology Institution 2012;2:77–84.
[138] Narin M. Türkiye'de uygulanan tarımsal destekleme politikalarında değişim. Ekonomik Yaklaşım Dergisi, Aydın Güven Gürkan Özel Sayısı 2008;19: 183–225.
[139] Adiyaman A. The importance of biodiesel for a solving of high agriculture cost problem in Turkey. Eastern Geographical Review 2008;13(19):105–22.
[140] Katar D, Bayramin S, Kayacetin F, Arslan Y. Ankara ekolojik koşullarında farklı ayçiçeği çeşitlerinin verim performanslarının belirlenmesi. Anadolu Journal of Agricultural Science 2012;27(3):140–3.
[141] Akinerdem F. Stratejik ve ekonomik değeri yüksek bir tarım alanı: Yağ bitkileri ve üretim politikaları. Gübretaş'la Verim Dergisi 2011;24:1–3.
[142] Sanli H, Canakci M. Dizel motorları için yükselen bir alternative yakıt: Biyodizel. III.Yenilenebilir Enerji Kaynakları Sempozyumu ve Sergisi 2005;1:233–7.
[143] Topal M, Arslan EI. Biyokütle enerjisi ve Türkiye, VII.National clean energy symposium; 2008, 241–8.
[144] Narin M. Energy agriculture in the world and in Turkey II., National Economy Convention; 2008, 1-18.
[145] Isıkli I, Acikalp E, Yamik H, Kurban M. Anlysis of biodiesel usage in diesel power plants, VI. International Advanced Technologies Symposium Elazig; 2011, 20–24.
[146] Aydin S, Aydin H, Ilkilic C. Effects of biodiesel on air pollution. Batman University Journal of Life Science 2012;1(2):329–38.
[147] Kaya Y, Kaya V, Kaya MÜ, Semerci A. Turkish oil crops production and future trends, I. National oilseeds and biodiesel symposium samsun; 2007, 158–163.
[148] Yasar B, .Türkiye'de biyodizel üretim maliyeti ve yaşanan sorunlar, VII. National Clean Energy Symposium Istanbul; 2008, 197–204.
[149] Yasar B, Eren O. Türkiye'de tarım sektöründe kullanılan petrodizelin çevresel etkileri ve biyodizel alternatifiyle karşılaştırılması, VII. National clean energy symposium Istanbul; 2008, 83–90.
[150] Sozen AN, Canakci M. Energy consumption in the world and Turkey—Biodiesel. In: Proceedings of the V. GAP engineering congress Şanlıurfa; 2006, 415–422.
[151] Yüksek Öğretim Kurulu Ulusal Tez Merkezi, 〈http://www.tez2.yok.gov.tr〉, 04/ 04/2013.
[152] United States Department of Agriculture Foreign Agricultural Service Approved by the World Trade; 2011.
[153] Satana A. Vegetable oil production in Turkey and Thrace. Marmara Geographical Review 2002;5:201–24.
[154] T.C.Gumruk ve Ticaret Bakanligi Koperatifcilik Genel Mudurlugu, 2012 yili Aycicek Raporu; 2013.
[155] Onurlubas HE, Kizilaslan H. Türkiye'de bitkisel yağ sanayindeki gelişmeler ve geleceğe yönelik beklentiler. Tarımsal Ekonomi Araştırma Enstitüsü 2007.
[156] Yasar O. Sanayi coğrafyası açısından bir araştırma: Türkiye'de tarıma dayalı sanayiler. Çantay Kitabevi Publications; 73.
[157] Tuglular T. Bitkisel ham yağ ithalatı büyüyor. TOBB Journal of Economic Forum 1999;6(1):46.
[158] Yasar O. Turkish manufacture of vegetable oil and their problems. Eastern Geographical Review 2004;9(12):275–92.
[159] FAPRI, World Oilseeds and Products, Agricultural Outlook; 2008.
[160] TUIK, Equilibrium values of products of oil seeds 2006–2010; 2012.
[161] Karakus U. Effects of biofuel policies on feed sector, Turkish Feed Manufacturers' Association Ankara; 2011.
[162] Arıoglu HH. Yağ bitkileri yetiştirme ve ıslahı course book, general publication no: 220; 2007.
[163] Kucuk İ.Türkiye'de yağlı tohumlar ve bitkisel yağ piyasası analizi ve alternative politikalar: Ampirik bir uygulama, Master thesis, Ege University; 2007.
[164] Tiras M. Agriculture of canola in Turkey. Eastern Geographical Review 2009;14(21):159–72.
[165] II.Tarım Şurası, VI.komisyon, Üretim ve pazarlama politikaları; 2004.
[166] Turkish Vegetable Oils and Fats Industrialists Association, Market prices, 〈http://www.bysd.org.rt/PiyasaFiyatlari.aspx〉 (2012).
[167] Arioglu HH, Kolsarici O, Goksu AT, Gulluoglu L, Arslan M, Caliskan S, Sogut T, Kurt C, Arslanoglu F. Yağ bitkileri üretiminin arttırılması olanakları. Türkiye Ziraat Mühendisleri Birliği VIITeknik Kongresi Bildiri Kitabı 2010:361–77.
[168] Kayisoglu B. A research on mechanization of sunflower with determination of plant properties for mechanization in Thrace region, PhD thesis, Thrace University; 1990.
[169] Tasan M. Effects of different refining methods (chemical and physical) on the composition and oxidative stability of sunflower oil, PhD thesis, Thrace University; 1999.
[170] Ozyurt I. Liquefaction of biomass waste as a sunflower seed shells and analysis of the obtained products, Master thesis, Yıldız Technical University; 2006.
[171] Mesut E. Sunflower waste butter biodiesel production and application of preheating, Master thesis, Karabuk University; 2011.
[172] Gucvardar E. Usage of biodiesel derived from soy oil methyl ester in diesel engines as an alternative fuel, Master thesis, Marmara University; 2006.
[173] Isler A. Canola oil methyl ester and e-diesel, Master thesis, Istanbul Technical University; 2007.
[174] Ozdemir A. Experimental investigation of use of canola oil as a diesel fuel, The degree of master science. Middle East Technical University; 2008.
[175] Karabulut AF. Optimization of biodiesel production from cottonseed oil, Master thesis, Ataturk University; 2008.
[176] Aydin H. Investigation of biodiesel of cotton oil the effects to engine performance and exhaust emissions of a diesel engine, Master thesis, Dicle University; 2007.
[177] Sarac M. Production of cottonseed oil by enzymatic extraction method, Master thesis, Istanbul Technical University; 2011.
[178] Gursoylu O. Usage of soy milk in cheese production, Master thesis, Pamukkale University; 2000.
[179] Hunt AO. The effects of two different lipid sources (fish oil and soybean oil) on the growth performance and body fatty acid composition of sea bass, PhD thesis, Cukurova University; 2003.
[180] Ogut H, Oguz H. Biodiesel: fuel for the third millennium. Nobel Publication; Ankara.
[181] European Commission, Energy for the future: renewable sources of energy, White Paper for A Community Strategy and Action Plan, COM (97); 1997, 599.
[182] 〈http://europa.eu/documentation/official-docs/green-papers/index_en.htm#2000〉; 2012.
[183] IEA Working Paper, Combining bioenergy with CCS, reporting and accounting for negative emissions under UNFCC and the Kyoto Protocol; 2011.
[184] Renewable Energy Policy Network for the 21st Century (REN21), renewables 2010 global status report; 2010.
[185] Clive J. Global status of commercialized biotech/GM crops: 2007. International Service for the Acquisition of Agri-Biotech Applications (ISAAA) Briefs 2007;37.
[186] Republic of Turkey Ministry of Economy, Foreign trade statistics, Annual and Seasonal Values, 〈http://www.ekonomi.gov.tr/index〉; 2012.
[187] Turkish Petroleum Industry Association, Sector Report of 2011.
[188] Republic of Turkey Ministry of Development The State Planning Organization (DPT), The eighth five-year development plan, petroleum products special committee report (DPR:2535-OIK:551); 2000.